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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE
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256 BROADWAY, NEW YORK.

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Some Leading Articles in this Number.

A Multiple-Spindle Lathe.
Making Brass Castings.
Bicycle Hub Tools.
Inventive Problems.
Care of Marine Boilers.
Machinery Exports.
Relative Merits of Drum and Ring Armatures.

NINETEENTH YEAR.

No. 11,
Mar. 12,
1896.

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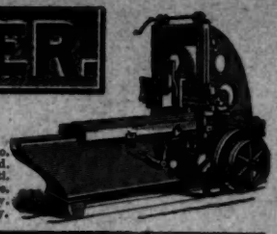

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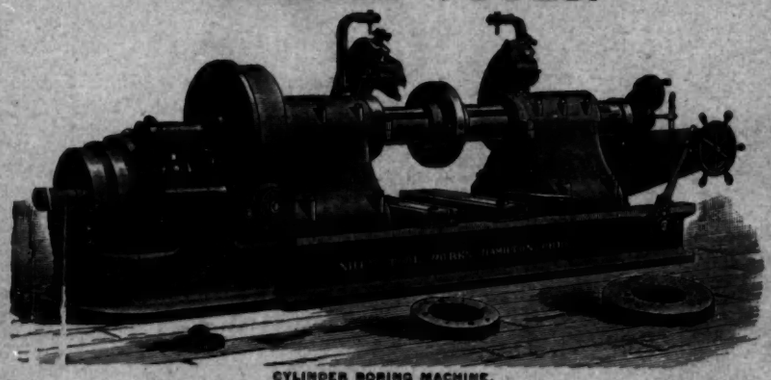

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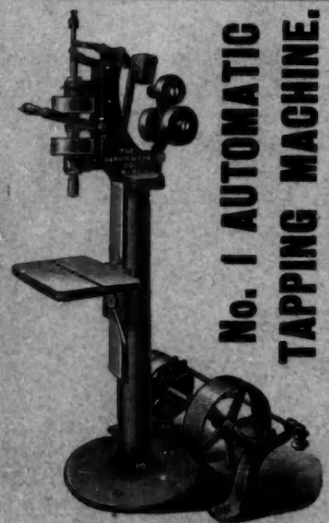

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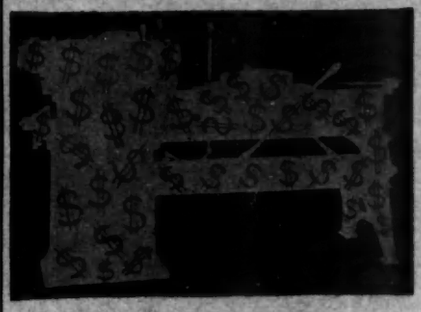

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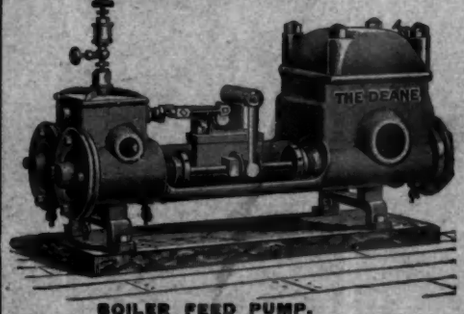

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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

Vol. 19, No. 11. WEEKLY. | NEW YORK, THURSDAY, MARCH 12, 1896. | $3.00 Per Annum. Single copies 6 cts.

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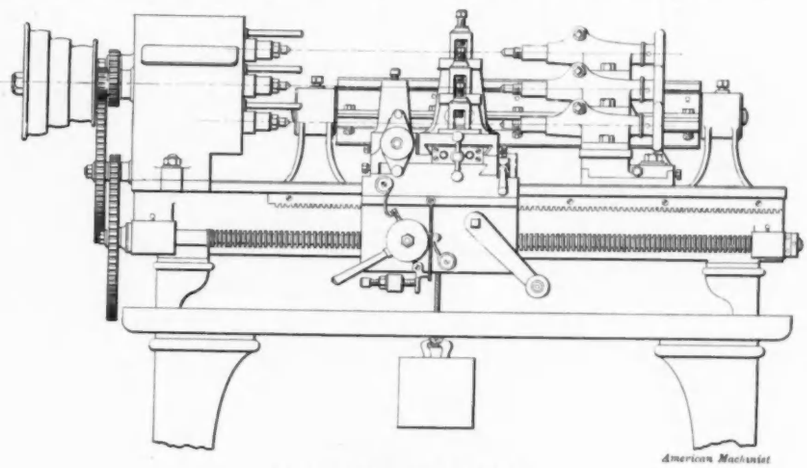
Entered at Post Office, New York, as Second Class Matter.

A Multiple Spindle Lathe.

We illustrate herewith a lathe designed and built especially for manufacturing operations where many duplicate pieces are to be turned.

As will be perceived, the lathe has three spindles which are geared together so as to be driven by a single pulley, and the spindles are placed, not vertically one above the other, as might be inferred from the engraving, but on a diagonal ascending line, the inclination of which is probably about 45 degrees. The live spindles are all in one head-stock, the tail spindles in one foot-stock, and the tool rests are all upon one block, which is moved in and out by cross-feed screw, in the usual manner.



MULTIPLE SPINDLE DRILL.

In addition to this, there is an additional slide below, which is used for turning tapers, or other forms not cylindrical; this slide being operated by a guide bar fixed in a revoluble bar supported on trunnions, as shown, so that any one of four guide bars may be brought into position at will. The weight shown keeps the guide roller against the bar, and the guide roller is adjustable, or rather, the lower slide is adjustable, by turning the screw shown at the left of the carriage.

The mechanism shown on the apron is for automatically opening the nut at any predetermined point.

By means of such a lathe, it is evident that three similar cuts on as many different pieces of work can be taken simultaneously.

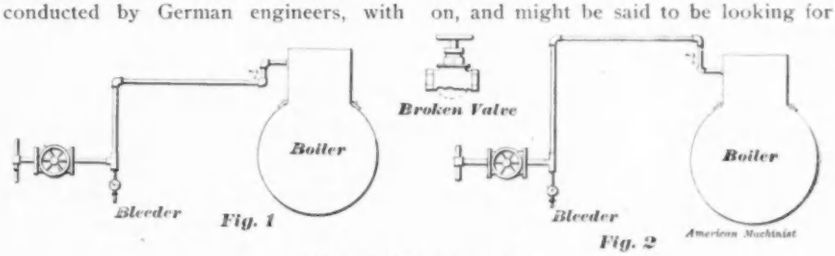
The lathe was designed and is made by Wagner & Andreas, Leipsic, Germany.

Water-Hammer in a Steam Pipe—The Cause and Its Cure.

BY WM. J. WILLIAMS.

The account given in your issue of January 2, 1896, of a series of experiments conducted by German engineers, with water in steam pipes, and also the reading from time to time of ruptured steam pipes that were known or believed to contain water, recall an incident of which I was an eye-witness several years ago. A 3-inch wrought-iron pipe was used to pipe a steam boiler to a steam engine; it had been in use at least five years, and until the fateful morning had never misbehaved itself, so far as known. I was sitting beside a fellow workman, waiting the starting up of the engine, which was the signal for the hands to begin the day's work. Happening to be looking towards the engine, I saw the engineer place his hands on the stop valve to start the engine, and instantly there was a sound of a terrible blow given in the neighborhood of the engine. I made the remark that it would not stand another blow like that; the words were scarcely uttered when it did receive another blow, followed by a crash and a roar of escaping steam. Fortunately, the engineer was not injured in the least, but was pretty well frightened, as were others in that immediate neighborhood. After the steam and excitement had cleared away, it was found that a portion of the stop-valve body (iron), opposite the valve and stem, had a hole in it perhaps 3 inches in diameter. The missing piece was found, and also the place where it had struck the boiler setting. It might be said that it was knocked out in a workmanlike manner; a clean, round hole was the result of the blow; the balance of the valve's body, valve, pipe and fittings were intact.

Not a great while after this occurred, I became the engineer, and matters went along quite smoothly for some time. I had the other man's experience to draw on, and might be said to be looking for something. Finally, on opening the bleeder to let out the condensation, one morning, preparatory to raising steam to working pressure, which was 45 pounds (the safety valves were loaded to this pressure only), there was a hammering in the



WATER-HAMMER CURED.

pipe which passed off without doing any damage. A few mornings afterwards, on opening the bleeder, as usual, the music commenced again; it knocked the rust out of the fittings and joints, and blow after blow followed. I closed the bleeder instantly, but it did not cause the hammering to be any less. I opened it again, and left for a convenient and safe place, if anything did occur, not deeming it prudent to remain and experiment with it. After running up against that thing twice, I came to the conclusion that it was time for me to begin to do some talking where it would do the most good. On the day of my second experience I told the proprietor what had occurred, and invited him to step up on a step-ladder and see how the steam pipe was connected to the boiler dome (the person who was responsible for the piping was present). He did as invited, and instantly after he looked at it he turned towards the man and said: "Why, how in the world did you do a thing like that?" and turning to me he said: "To-morrow morning we will change that, so get ready for it." The "thing like that" was as Fig 1; after the alteration it was like Fig. 2, and water-hammer was never heard in that steam pipe afterwards.

Now, what differences there were in the conditions existing within the pipe when it did and when it did not water-hammer may be left to conjecture. A difference there must have been, or it would have acted either good or bad always. When it acted badly, was the vertical portion of the pipe full of water (condensed steam), and was water also spread over the whole or part of the lower portion, or bottom of the upper horizontal section of pipe? If such was the case, it could not drain back into the boiler the way the pipe was arranged. Assuming such to be the case, the moment the bleeder in the pipe was opened, some of the water passed out, and at the same instant the steam in the boiler began to expand, springing into life, as it were, and being in contact with and above the water in the horizontal section of pipe referred to; the steam dashed the water in this portion of the pipe from one end of it to the other, seeking a place of release, and on the morning of the broken valve body it found it there. At other times, when there was no manifestation of trouble, the vertical section only contained water, and when the bleeder was opened the water was simply pushed out by the incoming steam from the boiler, and it passed quietly out.

I think those manifestations could be more properly called "steam hammer in steam pipes," than "water-hammer;" for, after all, steam is the prime agent of such destructive effects as are sometimes witnessed. It is, so to say, the handle of the hammer and the force; the water the head of the hammer; a combination which is not easily resisted.

Faulty piping is the chief cause of all such disasters. To pipe one boiler to a steam engine, or some objective point, should be simple enough; but to pipe two or more is quite a different problem. As shown, it is not necessary to have even ordinary working pressures to produce destructive effects when conditions are right for it.

Philadelphia, Pa.

Making Large Brass Castings.

BY C. VICKERS.

I have noticed that in brass foundries where the usual run of work is light, more or less trouble is experienced whenever a heavy piece is to be cast. A description of a successful method of running such pieces may be of interest to some:

Let us take, for example, a brass bearing weighing anywhere from 100 to 200 pounds. Such a casting can be cast from one pot, if the furnaces are large enough. In case the furnaces will not take a pot of this size, two or more smaller pots of metal can be melted and poured into a large pot, previously made red hot. The metal can then be cooled to suit and poured. It is a good idea for such foundries to keep a "hundred" pot, with shank to fit, on hand for such occasions. Of course, where there is an iron foundry in connection with the plant, a ladle of suitable size can be borrowed. But where this is not the case, the pot is best, as the average brass foundry possesses no facilities for lining and drying a ladle.

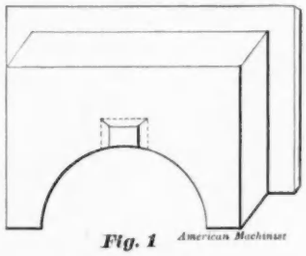


Fig. 1 American Machinist

GATING BRASS CASTINGS.

A few words also, in regard to the sand. The fine grades of brass sand are much too close for castings of this size, the work being sure to scab. I have, however, used No. 1 Albany with good results, but should recommend a coarser grade if it can be procured.

Bearing brasses are usually cast with the bearing down. The pattern having been put on the face board with bearing down, the cope is placed over and the runner sprues placed in position (these should be equal to height of cope), and the ramming proceeded with. In ramming, see that the sand is packed firmly around the sides of the pattern, so that no swellings can occur. Over the top, however, ram considerably lighter, as no amount of venting can be relied upon to fetch your casting up if it is rammed too hard over the back. Have one or more bars in the cope, cut to fit the pattern, and have the same well clay-washed. A good idea is to well nail the sides of the cope, driving the nails in aslant, about 2 inches apart all around the inside edge of the joint. After rolling, and before making your joint, well spike the edges around the pattern, as too great care cannot be exercised to have the sand well secured, nothing being more annoying than to have a drop-out when closing. In ramming the drag, see that the bearing is rammed firmly and evenly and well vented. Roll over again, and finish cope by removing sprue sticks and opening mouth of sprue. The cope is now lifted off, the pattern drawn and gates cut. The mold, after being well and carefully slicked, is floured and closed in the usual manner.

Experience has shown me that the best place in which to gate a bearing is in the center of one of the ends, as shown in Fig. 1, and the best form of gate to be used is a square one. Of course, no molder would leave the edges of his gates sharp, the general practice being to "thumb" them a little. The better way, however, is to cut off the edges so as to make a fillet of from an eighth to a quarter inch deep, as shown by dotted lines in Fig. 1. The gate should be well finished with the tools, leaving no sharp edges in the pathway of the metal, in the channel connecting the two sprues. Two sprues are used, the one next the casting being intended to feed it as contraction takes place, and should be from 2½ to 3 inches in diameter. The pouring sprue should be an inch and a half in diameter, and may be placed either before or on either side of the feeder, as space will allow (see Fig. 2), and about 3 inches distant at the joint. The pouring gate should be connected

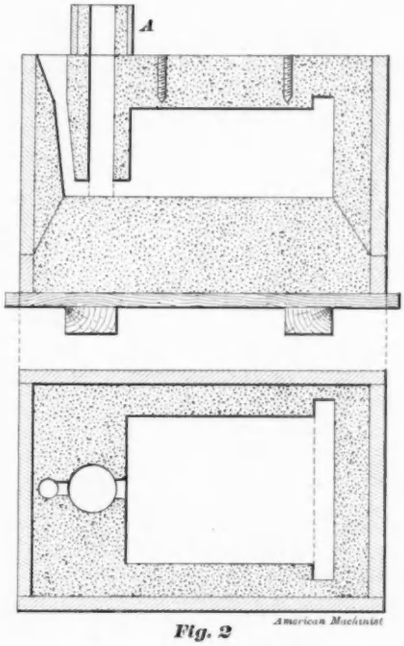


Fig. 2 American Machinist

GATING BRASS CASTINGS.

with the feeder by a channel cut in the cope.

There is nothing new about such a gate, as it is only the ordinary "skim" gate well known to all molders. The object, however, in this case is not so much to imprison any dirt and prevent it entering the casting, as to enable the sprue to be kept full in pouring, and so prevent the mold "drawing air," as would be the case if poured direct from the feeder. The feeder is not finished flush with the top of cope, but is carried 3 or 4 inches higher by means of a wooden box or an iron ring, as shown at *A*.

A good way to make this head is to use the butt end of a wooden bench rammer for a pattern. This leaves a head an inch or so larger in diameter than the feeder. Weight it down with a couple of pigs of copper, and cover it with a small core plate. In pouring, have the metal cool and rush it in, keeping the runner sprue full. When the mold is filled, the metal will be on a level with the top of flask; the feeder head being higher, will, of course, not be full. Now cover the top of the runner with a handful of sand; place on this a flat weight, previously placed handy; take cover plate off feeder head, and fill up with metal, pouring slowly. When full, wait a minute or two; the head will shrink down probably an inch or more; fill up again, dribbling it in, and your job is finished. The casting may now be allowed to cool, until you are sure it is no longer red. Then take off cope, and break off the gate by striking the feeder several blows with a sledge, hitting towards the casting.

A square gate, nicely filleted, and broken off when the casting is hot, will never break in, and will leave very little chipping be done afterwards. I would also suggest that the sand be cleaned off the casting while hot, as this makes a nice workmanlike job of it.

Boxes of 100 pounds weight may be cast two in a flask, using one feeder and sprue. Castings ranging from 400 to 600 pounds each must be poured from each end, using two feeders, etc.

Milwaukee, Wis.

Inspectors Wanted.

The Department of Buildings, City of New York, is in need of the services of a number of competent inspectors who understand the inspection of both cast iron and steel. The salary paid will, we are informed, be about $1,500, and the position comes under Civil Service rules.

The Secretary of the Navy has awarded the contracts for gun forgings for the battle-ships "Kearsage" and "Kentucky" as follows: Bethlehem Iron Co., South Bethlehem, Pa., for 13-inch forgings at 27.4 cents per pound; Midvale Steel Co., Nicetown, Philadelphia, Pa., for 8-inch forgings at 28 cents per pound.

Bicycle Tools—XX.

Last week I said that there were four systems of hub manufacture, but I now think there are five, and that the fifth is practiced by Pope at the Columbia Cycle Shops, Hartford, Conn. I did not go to Hartford to see the Pope hub tools. I went there to be sure that I wrote the Pratt & Whitney "Tucker" cycle-hub tools up to date, and to get better pictures of the Pratt & Whitney hub tools than I had been able to procure in any of the many factories where I have photographed their tools at work, feeling confident, since Pratt & Whitney keep a photographer on the premises, and because there is a force of draftsmen on Tucker's floor, that I would be able to procure a fine lot of pictures and drawings to fully illustrate the ingenious devices by which they have made their screw machine, originally intended to make heavy cuts in lines parallel to the axis of stock mainly, an efficient machine for the execution of the heavy side cuts demanded for the production of hubs from solid stock.

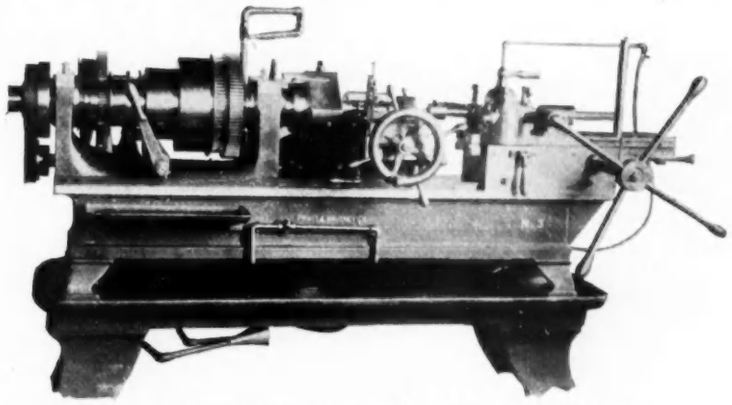


Fig. 133. FRONT VIEW OF NEW P. & W. HUB MACHINE.

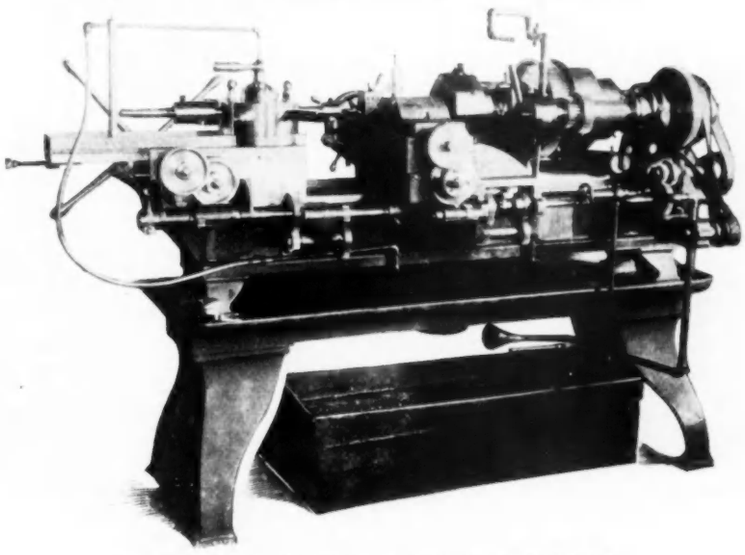


Fig. 134. REAR VIEW OF P. & W. HUB MACHINE.

Mr. Tucker was in Chicago, that delightful town of black snowfalls, which I so recently and so gladly left. The Pratt & Whitney photographer had no photographs nearly so good as my own, which I left behind me in Brooklyn, because I knew I would obtain better in Hartford. Mr. Whitney told me he did not know that the Pratt & Whitney Company wanted to say anything about cycle-hub tools. I told him that I had a great many photographs of the company's tools at work, none of them very good pictures, but that I could not pass the Pratt & Whitney tools without mention, and would not do so, and that, in justice to themselves, the company should give me the best it had to give. To this Mr. Whitney replied that the hub tools were in process of improvement, that they just now had the first of the new machines on Tucker's floor, but did not know that they would ever build another like it, and did not wish to have it illustrated in the "American Machinist." He said I could see what I could find in the photograph department, and what Tucker's men had in the drawing room, and I could talk to Tucker's foreman.

The photographer had nothing I cared for. The foreman on Tucker's job was very anxious to oblige me, and had no

information at all to contribute. The chief draftsman of the screw-machine tool and fixture department showed me a great lot of fine drawings and some rather startling photographs, but nothing I could reproduced here to advantage. Again I sought Mr. Whitney, and told him there was a machine just ready to ship and a machine making hubs, both on Tucker's floor, and again Mr. Whitney put his spectacles in his mouth and gave me his attention, and finally, after some conversation, his permission to photograph the new machine, and the machine at work, and to take a picture of Stannard's floorful of big "Spencer" Hartford Machine Screw Company's machines, in progress. The pictures of the new machine, taken February 25th, represent the latest Pratt & Whitney production in the way of hub tools; these two photos are reproduced in Figs. 133, front view, and 134, rear view, while Fig. 135 shows a Pratt & Whitney hub machine making hubs on Tucker's floor in the Pratt & Whitney shops, which may be supposed to represent Pratt & Whitney's ideas of hub tools, or at least their present practice.

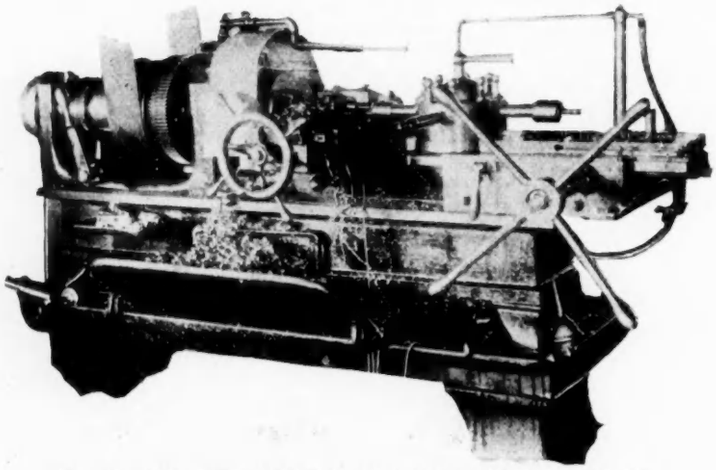


Fig. 135. HUB MACHINE AT WORK IN THE P. & W. SHOPS.

Figs. 133, 134, front and rear of the new machine, show a Pratt & Whitney screw machine with a 3-step cone for a good wide belt, fitted with a quick-speed shift, and an oil pump (rotary) which forces oil through an "Almond" flexible metallic tube into the top of the turret post, whence it is led through the bodies of the tools themselves directly to the work surface being cut. The Pratt & Whitney oiling is now quite in line with the chucking-drill practice on "Heyer's job," where the most of the hollow spindles made in the Pratt & Whitney shops are bored. This practice, carried to its present stage of development by Pratt & Whitney some years since, consists in carrying oil under heavy pressure to the rear of the tool body, which is bored for an oilway as far as the tool body is solid, and then when the tool begins to assume the cutting or chip-groove shape, continuing the oil duct in the form of two channels in the tool members, made tight by a covering of sheet brass soft-soldered over the open side of the channel; so that the oil, under a pressure of perhaps 150 pounds to the square inch, is delivered in a flood on the surface under operation.

Nothing is more noticeable than the changes in ideas regarding lubrication, which have been brought about lately by the necessity of heavy cuts, fast feeds, and high speeds in metal working, entailed by the fierce competition for the lowest cost-price production. Where it was formerly considered quite sufficient to oil a chucking drill anywhere, no matter if the oil never came within a foot of the cutting edge, we now see elaborate and costly and highly ingenious oil-forcing and conveying appliances in use, which deliver heavy jets of oil as nearly as possible at the cutting edge of the tool. It may be a question as to whether the actual cut of a chucking drill can be made under lubrication; it is hard to convince one's self that oil can possibly be present on the cutting lip of a drill which is being forced into solid steel; but the broad, undeniable fact remains patent to all observers, that the output of screw machines and chucking machines has been vastly increased, and the tool-making charges largely decreased, by the comparatively recent practice of forcing oil to the cutting end of the tool. Although this practice has only lately become common, there were in operation at least fifteen years ago (and I believe a much longer time), at the Springfield Armory, a number of gun-barrel drilling machines in which the drills, inclined at an angle of perhaps 30 to 45 degrees to the perpendicular, were led up through stuffing boxes into the bottom of a tank of lubricating fluid in which the piece to be drilled through lengthwise was wholly submerged. In these drilling machines the drill entered the stock at the lower end, at the bottom of the tank of lubricating fluid, which was consequently forced to follow the drill cut as it progressed upward.

I do not know when the Pratt & Whitney Company first began to pipe oil down the center of the turret stud of their screw machines; they do it now, and there does not seem to be anything that fills the office of a flexible oil tube so well as the curious invention of T. R. Almond, by which wire is so wound as to form a light yet perfectly flexible and very durable tube. I saw this same tube in use all through the Watervliet Arsenal, in the manufacture of great guns, and was informed that it was the only thing so far found suitable for the purpose.

Fig. 134, rear view of the Pratt & Whitney first operation cycle-hub machine, shows the oil pump at the right, and a double system of gears for both the turret slide-feed and the cross-feed. In Fig. 135, the 3-step cone is replaced with a 2-step cone, and the belt is, I think, 5 inches wide—maybe more. This machine makes a hub complete, except finishing the counterbore at one end, which is done at the second operation machine. The oiling is the same as shown in Figs. 133, 134. Production, 55 hubs per day, with one man in constant attendance. The work done is, of course, good.

The new machine, which the Pratt & Whitney Company do not wish described, is heavily powered. I should say it was belted to take five or six horsepower easily enough. It was not a very marked departure from present Pratt & Whitney practice, but was capable of great production, as every new candidate for cycle shop favor must be.

Unquestionably, there will eventually be a big lot of money lost in the cycle trade; but the strenuous efforts to reach the limit of low-cost production will so greatly increase the efficiency of small machine tools the world over, that the money will be well spent. This is well illustrated by the improvements constantly being made in the Pratt & Whitney tools that are used in cycle shops. A year since, this company believed their cycle-hub tools in nowise likely to meet successful competitors. Now they are hard at work to meet their own ideas of what hub tools should be.

I am unable at this time to give an account of the Columbia hub tools; though I may say that I have reason for believing that the method pursued is to first bore and ream them, and then to put them on an arbor and mill the outside to shape, using rotary milling cutters of the required form.

HUGH DOLNAR.

It is being charged by some manufacturers who have been interested in the Manufacturers' Association, that it is being made entirely too much of a political organization, and is being especially run in the interest of McKinley as a Presidential candidate. Something of a revolt among St. Louis members is reported on this account.

On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

In the present article I propose to present the remaining solutions of Problem No. 6, presented by me in issue of May 3, 1894, at the suggestion of Mr. Miller. I trust that the unexpected time which has elapsed since these solutions have been forwarded to me has not destroyed the interest manifested in the problem when announced.

Many changes have taken place since that date. Not the least notable of these is the change in the form of our old friend "American Machinist." When it appeared in my mail in its new shape, I confess to a feeling of regret much the same as one realizes when meeting an old friend, after a long period of absence, upon whom time, ever busy, has worked its will. But, I soon found, on looking through its pages, that there was no change in the spirit of the publication, which, so far as I know, stands entirely unique and unrivaled as the model shop newspaper of the English-speaking world. Asking pardon for this digression, I return to the matter in hand.

Before presenting the solutions to Problem 6, I will briefly restate the problem in general terms, in such manner as I hope will enable those who did not see it when first announced, and those to whom it is now but a dim recollection, to comprehend its general import with the aid of the solutions herewith presented.

The motion which suggested the problem was a peculiar mechanism concealed in a box attached to a German lathe for backing off the teeth of milling cutters. The tool post of this lathe was moved by a carriage toward and from the cutter, the teeth of which were to be backed off, by means of a horizontally-revolving cam on a vertical shaft, which, through bevel gears, was operated by a splined shaft extending between the carriage and the tail stock, inside the bed of the lathe. The box, being attached under the bed of the lathe near the lower end, contained mechanism driven by gearing actuated through a shaft running parallel with the ways at the rear of the lathe, and taking motion from a set of change-gears placed at the head of the lathe. The action of this mechanism, adjustable for different pitches of spiral, was to modify the motion of the backing-off tool in such manner as to give the proper cut through the entire extent of the spiral. Those who can refer to Mr. Miller's letters written for the "American Machinist" during his stay at the Chicago Exposition, are recommended to reperuse his description of this lathe given in the issue of July 20, 1893.

With reference to a question raised by Mr. John F. Giddings, of Providence, R. I., relating to a solution contributed by Mr. Albert L. Colburn, of New Haven, Conn., and printed in the issue of September 13, 1894, I made some comment in my article in issue of February 28, 1895; and under date March 5th following, Mr. Colburn wrote the following in reply:

"I note in the 'American Machinist' of February 28, 1895, what Mr. John T. Giddings, of Providence, R. I., has to say regarding my solution of your No. 6 problem; also that you turn his case over to me, if I wish to take it up. The details of the solution, as they appeared in the 'American Machinist' of September 13th, had slipped from my mind. However, I have looked them up again; and I must say that with the description I gave at that time, reinforced by your explanation in the 'American Machinist' of February 28th, I do not see how much more can be said to make the solution plainer. Mr. Giddings, no doubt, thinks there should be ten retarded revolutions of the splined shaft to one revolution of the spiral on the cutter, because there are ten teeth in the cutter; and if the cutter had twenty teeth, or any number of teeth, the splined shaft should have as many retarded revolutions to one revolution of the spiral as the cutter has teeth.

"According to his idea, we might suppose a case by saying the cutter is to have but one tooth; then the splined shaft will be geared to make the same number of revolutions as the spindle; in which case he will, of course, admit that my change-gears on the foot end of the screw, and bevel gears of twenty to forty teeth, are correct for one tooth in the cutter, and that by this gearing the splined shaft is retarded one revolution in 36 inches' travel of the carriage. Now, suppose we change the gears at the head of the lathe so that the back shaft and splined shaft make twenty or any number of revolutions to one of the spindle, which, of course, means that number of teeth in the cutter. When the carriage has traveled 36 inches, the splined shaft will have been retarded one revolution just the same, regardless of how many revolutions it makes to one of the spindle; or in a travel of 36 inches of the carriage. I think Mr. Giddings will find that his 60 to 36-tooth gears and miter bevels will give him a spiral on the cutter of one in three and six-tenths inches.

"It may be that my reasoning is incorrect, but I cannot see it in any other light at present. However, if Mr. Giddings or any other reader of the 'American Machinist' can give me more light on the subject, I shall not only be glad, but anxious to receive it for my own benefit, as well as for the benefit of others.

"As my time is somewhat limited, I have not read all of the solutions of your different problems, but have looked them through; and I think, for one who has time, they are first-class mechanical reading and instruction."

Having presented Mr. Colburn's remarks, it is but fair to print the following letter from Mr. Giddings in reply to my criticism referred to above, by Mr. Colburn. His letter, dated March 2, 1895, is as follows:

"Judging from the remarks which you made at the end of my criticism of Mr. Colburn's solution of Problem No. 6, published in the 'American Machinist' of February 28th, I think you misunderstood the idea I intended to convey. I will admit that if the cutter had but one tooth on a spiral of 36 inches to one turn, and that the splined shaft and cam which actuates the tool which backs off the tooth of the cutter, made the same number of revolutions as the spindle and cutter, then the splined shaft would need to be retarded but once during the 3,600 revolutions of the spindle and the 36 inches travel of carriage, as it must be admitted that the backing-off tool would need to be retarded or advanced (according to the inclination of spiral) during one revolution of the spindle and cutter in order to follow the path of spiral. But if the number of teeth in the cutter is increased to ten, then the splined shaft must be increased to ten times the number of revolutions, or to 36,000.

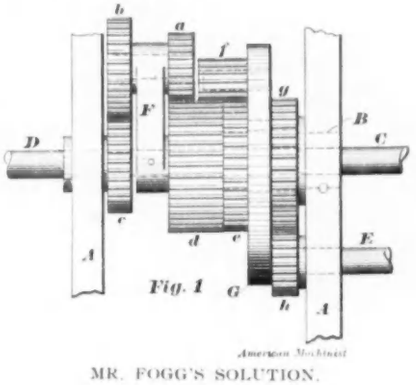


Fig. 1

MR. FOGG'S SOLUTION.

"And the modifying effect of the change-gears at the foot of the lathe must be increased to ten times the amount also. In this case, if the spindle makes 3,600 revolutions the splined shaft and cam would need to make 36,000 — 10, if the spiral is right-hand and the carriage feeds from right to left, and 36,000 + 10 if the spiral is left hand."

In Fig. 1 is presented a solution contributed by Mr. Charles H. Fogg, of Boston, Mass. Mr. Fogg's description of this arrangement is as follows:

"In the sketch *A* represents cross-ribs in bed of lathe; *B*, a hub fastened to one of the ribs as shown, and forming a bearing for the shaft *C*, which is driven from the back shaft (not shown) by means of suitable change-gears outside of the lathe bed. *D* is the splined shaft which drives the vertical shaft carrying the cam for actuating the slide and cutting tool. *E* is driven from the lead screw (not shown) by means of suitable change-gears outside of the lathe bed. The arm *F* is secured to

the shaft *C* and revolves with it, carrying on a shaft at its outer end gears *a* and *b*, both being keyed to shaft and revolving together. The gear *a* having half as many teeth as *d*, and the gears *b* and *c* having an equal number, shaft *D* will make as many revolutions as shaft *C*, but in an opposite direction, provided the change-gears from the lead screw to shaft *E* are disengaged. The gear *c* is keyed to hub *B*, and cannot revolve; and it has one tooth less than gear *d*, but it is of the same diameter. The gear *g* revolves on the hub *B*, and is driven by the pinion *h*, on the shaft *E*.

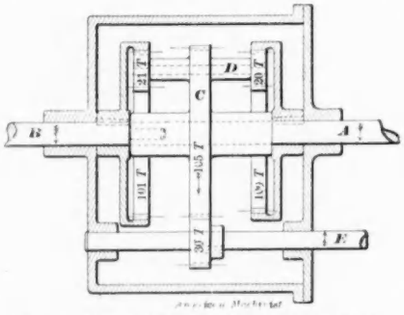


Fig. 2. MR. ROBERTSON'S SOLUTION.

Keyed to the gear *g*, and revolving with it, is the disk *G*, carrying the pinion *f*, which revolves freely on a stud and is in mesh with gears *d* and *e*.

"Now, if we assume the gears *d* and *e* to have sixty and fifty-nine teeth, respectively, and the ratio of gears *g* and *h* as two to one; then, for a cutter of ten teeth and a spiral of 30 inches (right), calling the feed $\frac{1}{64}$ of an inch, and the lead screw having five threads per inch,

C should make 640 revolutions
g should make 1 revolution
d should make $\frac{1}{60}$ revolution
Lead Screw should make 5 revolutions
} in the same direction.

D should make $640\frac{1}{30}$ revolutions,

"For a left-hand spiral, an intermediate gear on a stud would be necessary in the change-gears between the lead screw and shaft *E*."

So far as I can perceive, Mr. Fogg's solution covers the ground, and his reasoning appears to be correct. The arrangement, moreover, is good and mechanical, and susceptible of a good durable design.

Fig. 2 is a solution contributed by Mr. C. J. Robertson of Plainfield, N. J. In his description of this movement which follows, Mr. Robertson endeavors to supply some deficiencies in Mr. Colburn's solution published in issue of September 13, 1894. He writes as follows:

"Upon reading over your article in September 13th, 1894, issue, it occurred to me, in connection with Mr. A. D. Colburn's able solution and line of reasoning, that in Mr. Miller's description of the lathe there was nothing concerning the change-gears at the tail-end of the lead screw to suggest a change in direction as well as angular velocity (although the term "change-gears" may very justly be said to comprise this), nor anything of any way of holding the shaft (at other times driven by these change-gears) stationary when the change gears are thrown out of action for straight cutters.

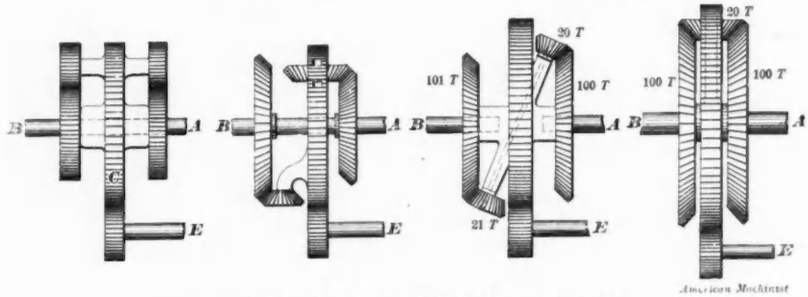
"It also occurred to me that, in Mr. J. T. Slocomb's very ingenious solution, it might be difficult to arrange a convenient way to manipulate the clutch device on the bevel gears, if necessary or desirable to do so, without necessitating getting access to the box for the purpose. At the best, this would add parts and would not make for simplicity.

"In the sketch herewith submitted, representing a means to the end in view of the above considerations, *E* represents the shaft entering the box and driven by change-gears from the lead screw; *A*, the shaft driven by gears from back shaft, and *B*, the splined shaft in the bed of lathe—the inner end of *A* being journaled around the end of *B* as Mr. Slocomb shows it, which seems about as good a way as any to gain this bearing.

"Upon *A* is fastened an internal gear of 100 teeth; upon *B* another of, say, one tooth more; and running loose upon the end of *B* is a spur gear *C* of, say, 105 teeth, driven in the direction of its arrow by a pinion of, say, 30 teeth on shaft *E*. The gear *C* has upon it a boss or hub through which runs the shaft *D*, having a pinion of, say, 20 teeth on one end, driven by the internal gear of 100 teeth, and on the other end a pinion of one tooth more (21), driving the internal gear of 101 teeth.

"In this arrangement, *E* is always driven (whether for straight or spiral cutters of either direction of twist) and always in the same direction—thus simplifying change-gears and removing necessity for locking anything—but at different velocities, the relative diameters of the internal gears and pinions being chosen such that, if *C* were held stationary, *B* would be driven enough faster than *A* to more than accommodate the cutter with the greatest amount of twist to the inch ever requred (which, of course, might be other than the one tooth more that is shown here); and the speed of *C* being made by the change-gears and the pinion driving *C* to rotate in direction of its arrow, so that if *A* were held stationary and *B* were to move, *B* would be driven in the direction opposite to its arrow, on account of *D* revolving around *A* and *B*, and by the difference in ratio of angular velocities of the two pair of internal gears and pinions. Thus we gain the means of depriving *B* of the proper amount of the excess of motion imparted to it by the rotation of *A* for cutters of one direction of spiral, thus causing *B* to rotate turn for turn with *A* for straight cutters, or of depriving *B* of so much motion due to its drive by *A* that *D* rotates slower than *A* the proper amount for spirals of the other direction. Of course, the shaft *D*, and its boss and pinions, would be counterbalanced by casting a hump on opposite side of *C*; and if motion were used for anything requiring it, the drive could be equalized by having two shafts *D* opposite one another, instead of one. The adding or subtracting of one tooth giving odd figures, if difficulty be experienced in getting change-gears, the change-gears at the head of the lead screw could vary slightly without materially affecting the feed, these gears being included in plate giving change-gears for the tail-end, as if all one combination. Also, the shaft *D* might be at an angle to *A* and *C*, making internal gears and pinions bevel slightly; and this might require odd figures if it was necessary to go to this length of increasing the cost of the machine.

" Let *a* = number of inches in total length of work, if straight; or, if spiral, the length of work to one revolution of the spiral;
b = number teeth in cutter;
c = number threads per inch in lead screw;



MR. ROBERTSON'S ALTERNATIVE SOLUTIONS.

d = revolutions of work in 1-inch feed;

∴ (1) *a d* = total number revolutions work in length, *a*.

(2) *a c* = number revolutions lead screw in length, *a*.

(3) *a d b* = number revolutions shaft *A* in length, *a*.

(4) *a d b* or *a d b* + *b* or *a d b* − *b* = number revolutions *B* in length *a*.

∴ First, supposing *E* fixed,

$$1 \text{ revolution } A = \frac{100}{20} \text{ revolutions } D.$$

$$\therefore 1 \text{ revolution } A = \frac{21}{101} \times \frac{100}{10} \text{ revs. } B;$$

$$i.e., 1 \text{ revolution } A = \frac{105}{101} \text{ revolutions } B.$$

"Second, supposing A fixed, B free to move, and E driving C,

1 revolution $C = \frac{100}{20}$ revolutions D; but

1 revolution $D = \frac{21}{100}$ revs. B;

$\therefore$ 1 revolution, $C = \frac{100}{20} \times \frac{21}{101} = \frac{105}{101}$ revolutions B with E running as indicated by its arrow and driving B in a direction against its arrow,

(5) 1 revolution $A = \frac{105}{101}$ revolutions B;

$\therefore$ $a\,d\,b$ revolutions $A = \frac{105}{101}\ a\,d\,b$ revolutions B;

but 4 or 5 $a\,d\,b$ revolutions A should be = ($a\,d\,b$ or $a\,d\,b + b$ or $a\,d\,b - b$) revolutions B;

$\therefore$ rotation of C will require to drive B against its arrow $\frac{105}{101}\ a\,d\,b +$ (adb ($b \times 1$ or 0)) revolutions B to length a, from which may be deduced:

revolutions E for straight cutters $= \frac{2\ a\,d\,b}{15}$;

and for spiral cutters $\frac{4\ a\,d + 101\ b}{30}$

to the total length a of work, if straight, or length a to 1 revolution of spiral.

Then, since lead screw rotates $a\,c$ revolutions to a length of work (equation 2), the ratio of change = gears for straight cutters =

$$c \text{ to } \frac{2\,d\,b}{15} = c \text{ to } \frac{2\,d}{15};$$

and for spiral cutters the ratio would be

$$a\,c \text{ to } \frac{A\ a\,d + 101\ b}{30}.$$

"A cheaper method would be unequal spur-gears fastened to A and B, in place of internal gear shown (which would not give such a steady drive, but would probably be steady enough); but which would possibly result in such a high ratio of change-gears between E and the lead screw as to be unwieldy to reduce without a good deal of compounding, which would be a matter of trial of figures to see. This possible trouble with the spur-gear arrangement could be remedied by having change-gears to drive E connected to A, instead of to lead screw—for which there seems to be, again, the disadvantage that the feed per inch is not changed as often as the number of teeth in the cutter; and, therefore, with gears from the lead screw, the placing of the proper change-gears for a given cutter is simpler. The reason that, with spur gears, the ratio of change-gears might be higher, is that an addition or subtraction of one tooth to one of the second pair results, in the case of the spur-gears, in much greater change of resulting velocity ratio than with internal gears, where one tooth is added to driver and driven or subtracted from both; and in the driven gear, one tooth does not cut much of a figure among so many; but with spur gears, adding one tooth to one of the pairs takes from the mate, and they are both small gears anyway.

"In September 13th issue, on page 6, first column and twenty-third line down, you have probably noticed that ten revolutions is correct, not 'one revolution,' the sentence preceding correctly stating that during 3,600 revolutions of the spindle one circuit of points on the barrel is lost, and therefore ten points to a circuit—one revolution of cam to each point.

"Note, also, sketches of bevel gear arrangements.

"I trust that this problem business will be assiduously kept up, as it is one of the best lines on the paper."

In the "American Machinist" of August 8, 1895, will be found a full description of the lathe referred to, with drawings.

I will now announce a new problem, Problem No. 8 (see Fig. 3). In this figure, S and S^1 are two rotating shafts supported in box bearings. D is a spur-gear keyed to S, and D^1 is another spur-gear keyed to S^1. These gears are alike in all respects. E and E^1 are two wheels carried also on the shafts S and S^1. Their peripheries are smooth, and are brought as closely together as will permit their turning with, or on the shafts without rubbing together. Any mode of attaching these wheels E and E^1, to the shafts which may be found compatible with the solution of the problem is permissible.

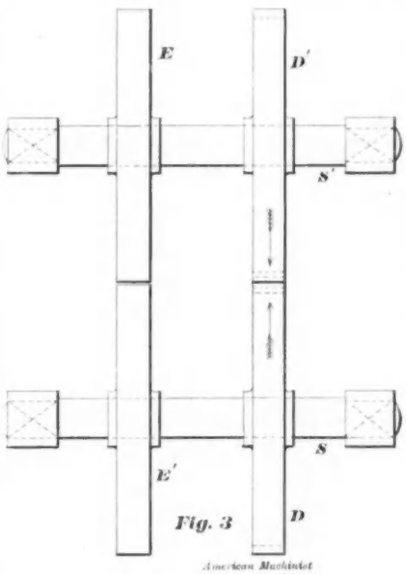


Fig. 3

A NEW PROBLEM.

It is required to supply mechanism wholly supported by the shafts S S^1, by which, when E and E^1 are turned, each at same angular velocity, through an arc of 90 degrees, by the revolution of the shafts S and S^1, E shall, while E^1 is revolving 10 degrees more at the previous velocity, move through an arc of 20 degrees, thus gaining ten degrees on E. This event is required to take place at each quadrant of the motion of E^1, so that when E^1 has moved through an entire revolution, E has moved through an arc of 400 degrees.

The only restriction to be observed is, that these movements may take place either at slow or at a considerable velocity; that is to say, any particular rate of movement within moderate limits must not affect materially the action described.

As this is a problem which presented itself to me a short time since, in the course of my regular work, and proved an interesting one before I had satisfactorily solved it, I trust it will also interest others.

I sincerely hope that my friends among the readers of the "American Machinist" will not be discouraged from sending in solutions on account of delay in presenting solutions forwarded for Problems 6 and 7, which delay, so far as I can now foresee, is not likely to be repeated.

To Dispense With Chimneys.

Herr Gruenwald, of Holzminder, Germany, has recently patented a device for disposing of the smoke from boiler fires. The waste gases of combustion are drawn through a conduit at the end of which is a ventilating fan, which forces them into the lower part of a gasometer. Here they bubble through a sheet of water, where they are cleansed of the solid particles held in suspension, and collect in the upper part of the gasometer, whence they may be set free into the atmosphere or used for any purpose desired. The wash water is continuously renewed and, as a measure of economy, the combustible solid matter contained in it may be extracted, by decantation or evaporation, and used a second time for fuel. The draught is regulated simply by varying the load upon the bell of the gasometer. The system is applicable only where power is available for operating the ventilator, but one fan may perhaps suffice for a whole battery of boilers. Besides the smoke-consuming property of the invention, an important feature is in dispensing with chimneys, as well as the stacks on men-of-war, which are valuable points, and which, with the accompanying smoke, render torpedo boats difficult of concealment from the enemy. The sole drawback to to this device seems to be the difficulty of protecting the parts of the ventilator from the action of the hot gases, and if that obstacle be overcome and no others be encountered, such a smoke consumer may prove a great boon to some of our inland cities. The description we have given is contained in "Mittheilungen ueber Gegenstande des Artillerie und Genie-Wesens."

A Committee of the House of Representatives has reported favorably a bill which makes the engineers and their assistants on a steam vessel, officers of that vessel, and requires that officers shall be citizens of the United States. This subject was discussed in our issue of January 30th.

Care of the Modern Marine Boiler—III.

BY T. W. KINKAID,
Passed Assistant Engineer, U. S. N.

The large number of water-tube boilers in use on shore augers well for the adoption of this type for marine purposes. In the use of water-tube boilers at sea the French are the pioneers, and, in spite of some expensive experiences, they still, apparently, have not lost faith. Numerous articles have been written, in which the respective advantages of shell boilers and water-tube boilers have been marshaled against each other; but, without going into the subject exhaustively, we may here consider several items in regard to the care of the water-tube type.

Of course, not all water-tube boilers are of equal merit; but, as a rule, the services of a boiler maker are not so frequently required as with the older type of boiler. If a water-tube splits or wears out at the tube sheet, plugging with soft iron or copper tapered plugs can be resorted to, and is sometimes easily accomplished. It is generally best to wait until a considerable proportion of the tubes are plugged before laying up the boiler for general repairs. If, for instance, 15 per cent. of the tubes are plugged, the remaining heating surface will give the boiler an efficiency not much below that belonging to the full heating surface. In the case of all-pipe boilers, which are generally used for low powers, and which seldom admit of repairs to individual tubes, provision is usually made for hoisting the boiler out, so that it can be shipped to a shop for the necessary repair work. The calked joints are few in number, and are usually not exposed to the most intense heat.

When only a moderate draft is used, sweeping the tube surface with a jet of steam or compressed air is necessary. On some of the newest lake steamers, branches from a compressed-air main lead to different points inside the boiler casing, and the sweeping is accomplished by the opening of a single valve on the air main.

The casing of the water-tube boiler is an important part of the structure, as it has to insulate against furnace gases that are at a high temperature—in some portions as high as 700 or 800 degrees Fahr.; and in cases of bad design, the temperatures to which the casings are exposed are undoubtedly much higher. In the Scotch boiler, on the other hand, the temperature to be lagged against depends solely on the pressure of the steam carried, and is comparatively mild. Hence the importance of watching the casing of a water-tube boiler and keeping it in perfect repair.

The perfect provision for expansion and contraction, which usually obtains, has earned for the water-tube boiler the reputation of being able to stand forcing better than the old-type boiler; but here it must be remembered that cleanliness of the wetted tube surface is all the more essential with the high temperatures of furnace and furnace gases, and that a water free from oil, sediment and soapy compounds should be used. Alkalies should be employed to neutralize grease, but the water ought not to be allowed to go too long unchanged. The use of salt water induces priming; but, then, many water-tube boilers depend largely on priming to establish circulation. In fact, the boiler of the future will be able to steam with salt water when required.

External corrosion of the tubes, due to excessive "sweating," seems to be a malady of water-tube boilers. Of course, the sweating occurs only when the boiler is idle. There are several ways of combating it. Some makers employ brass or copper tubes—an expensive remedy, but one which insures good heat transmission. A method which has been tried with some success consists in the burning of certain qualities of tar in the cold boiler, the fire being managed so that part of the tar is distilled and then condensed on the cold tubes, forming a protective coating. Perhaps spraying a petroleum oil from a special long-billed syringe would accomplish the desired end more satisfactorily.

A practice has been revived, in the last two or three years, of throttling the steam at the boiler stop valve, so that the resulting expansion of the steam to a lower pressure in the steam pipe can evaporate the entrained water. The employment of this method of drying steam has been attended with some success in the cases of several torpedo boats; but it is difficult to see why an ordinary centrifugal separator does not constitute a more satisfactory arrangement, both as regards economy of steam generation and decreased liability to leakage and rupture. A few feet of superheating surface will effectually dry the steam; but such surface is liable to be burned when the entrained water contains salt or sediment.

The fitting of spiral bafflers in the tubes of Scotch boilers, and the employment of Serve (or internal-ribbed) tubes, have been attended with a gain in economy. After the furnace flame has been quenched by contact with cold heating surfaces and by radiation, the furnace gases, although still very hot, can no longer radiate their heat, but must give it up by actual contact with surfaces. So the more surface there is provided, and the better it is disposed to meet the flow of gases, the better the economy. The tubes of water-tube boilers are usually so arranged as to give a good baffling effect, and, in addition, sheet-iron or tile bafflers are fitted. Persons in charge of such boilers ought to carefully study the baffling question, and should experiment occasionally in the hope of obtaining maximum results.

Machinery Exports and Imports in 1895.

The Treasury Department has just published the completed statistics of the export and import trade for the calendar year 1895, and we extract therefrom the following figures relating to manufactures of iron and steel in general, and machinery in particular:

The total exports of manufactures of iron and steel amounted to $35,071,535 in 1895, as against $29,943,729 in 1894, $27,000,134 in 1890, and $16,622,511 in 1885; they exceeded by more than $4,250,000 the figures of any preceding year. These figures are exclusive of agricultural implements, of which the exports amounted to $5,319,885 in 1895, as against $4,765,793 in 1894; and of railway and street cars, of which $2,648,267 were exported in 1895, against $2,297,376 in 1894. With these additions the totals are $43,039,687 in 1895 and $37,006,898 in 1894, an increase of $6,032,789.

The leading items constituting the manufactures of iron and steel exported were the following:

	1894.	1895.
Cutlery	$160,879	$170,166
Firearms	640,099	845,110
Builders' hardware	2,452,732	2,766,532
Saws and tools	2,019,199	2,012,000
Machinery	10 715,520	12,115,118
Locomotives	1,567,464	2,110,244
Boilers and engines	862,171	631,221
Nails and spikes	527,308	569,435
Printing presses	160,303	217,678
Railroad rails	356,186	362,131
Scales	292,055	387,710
Sewing machines	2,064,787	2,988,006
Stoves and ranges	240,936	289,462
Wire	1,304,794	1,375,195

Considering machinery (inclusive of locomotives, boilers and engines) by itself, we find that the exports were made to the different countries in the following order and amounts:

	1894.	1895.
Great Britain and Ireland	$2,188,471	$2,611,724
Mexico	1,682,492	2,029,780
Brazil	1,283,592	1,596,540
Canada	1,330,142	1,527,885
Africa	441,015	1,191,797
Asia	488,355	779,941
Germany	514,033	667,486
Cuba	1,916,061	505,628
Central America	364,127	502,622
France	316,228	381,611
Australia	298,820	351,804
Argentina	195,627	240,886
Santo Domingo	309,824	121,057
Colombia	136,704	100,715
Other Europe	757,549	1,221,246
Other South America	631,848	709,926
Other West Indies	287,687	314,200

The report does not state the destination in detail of all the different items of iron and steel manufactures, but of such as are given, Great Britain is invariably the principal purchaser; and in the item of sewing machines, which were not included in the above table, Great Britain and Germany together had $1,669,396 out of a total of $2,988,006 exported in 1895—in other words, our principal purchasers were the very countries whose industrial

development is greatest, and whose competition is most generally feared. Verily, our manufacturers have every reason to be proud of the showing.

Turning now to the imports, we find the totals to be $25,772,151 for 1895 and $20,845,576 for 1894, composed mainly of the following items:

	1894.	1895.
Tin plates	$12,022,466	$11,462,423
Pig iron	407,638	1,337,978
Bar iron	377,397	772,822
Steel	809,184	1,610,889
Sheet and plate, iron and steel	1,197,671	727,638
Wire and wire rods	1,438,159	1,807,608
Cutlery	1,220,707	2,092,038
Firearms	294,230	623,760
Needles	286,655	314,426
Machinery	1,189,965	2,199,518

The foregoing figures clearly show what all students of the question have long known, namely, that our exports of iron and steel manufactures far exceed our imports of the same article, and that so far as machinery in particular is concerned, exports exceed imports nearly seven-fold. It is, indeed, an interesting and significant fact, that our machinery exports to Great Britain and Ireland alone in 1895 exceeded our machinery imports from all countries taken together. That our machinery export trade is only in its infancy, and that its possibilities are great, must be apparent to every one.

Two-Stage Air Compression in Single-Acting Cylinders.

BY FRANK RICHARDS.

The following, from a correspondent in Prato, Italy, has been handed to me, and it seems to demand some serious attention, especially as I have received some similar suggestions from other parties:

"In 'Compressed Air,' by Frank Richards, Chapter viii., it is said that 'the arrangement of the tandem, single-acting, two-stage compressing cylinders is about as bad a one as could be devised for an air compressor, and no possible change in the relative capacities of the two cylinders can make it right.'

"The figures given in support of this statement show that the high-pressure cylinder takes always a greater part of the power than the low-pressure one. Now, enlarging the low-pressure cylinder, so that it would take a greater part of the work, would seem to tend to equalize the power. Should not the statement mean that the ratio of capacities cannot be made to equalize the powers for every pressure, but can be made to do so for one given delivery pressure?"

The sentence quoted from my book was written with due deliberation, and I think that the context fully justified and sustained it. I showed, for instance, where the air was compressed in the first cylinder up to the full delivery pressure, and where the work of the second cylinder, and its piston, consisted only of expelling or delivering the air against the receiver pressure, that even then the working stroke of the second cylinder required 1½ times the power required for the compressing stroke of the first cylinder. This was the condition of affairs when compressing and delivering the air at a pressure of 35 pounds. With the same compressor delivering the air at six atmospheres, 75 pounds gage, the working stroke of the second cylinder would require 2½ times the power required for the compressing stroke. As in this latter case the first cylinder was only compressing the air to 35 pounds, as before, while the second cylinder was completing the compression up to 75 pounds, and then delivering the air at that pressure, we might, as suggested by the correspondent above, reduce the capacity of the second cylinder (this would have the same relative effect as increasing the capacity of the first cylinder, and at the same time it would not change the free-air capacity or the actual work of the compressor) and let the first cylinder compress the air to a higher pressure, or even clear up to 75 pounds; but even then there would be a large excess of work on the compressing stroke, and at the same time we would have given up every possibility of advantage to be derived from the compound or two-stage compression. With the first cylinder compressing as it did to 35 pounds, there was some chance of cooling the air before the final compression; and if this chance was accepted, and if the air was completely cooled before the final compression, there would be a saving of power required for the compression. But as soon as this cylinder was made to compress to any higher pressure, the advantage of the intercooling, and of the consequent reduction of volume and saving of power, would be immediately diminished; and if the first compression was carried up to the delivery pressure, the opportunity for intercooling would have disappeared entirely, and the two-stage compressor would be a two-stage compressor in name only.

In the most economical two-stage compression the first compression should be to less than one-half of the final compression, and the cooling between the stages should be as nearly as possible to the normal temperature. The burden of proof should be upon the builder of the two-stage compressor, to show that the first compression is not carried too high, that the air is actually delivered into the second cylinder and that the second compression begins at a temperature as near as possible to that at which it began in the first cylinder; and that the intercooling, with all that it implies, does not itself cost too much.

It is to be remembered that the inequitable distribution of power in the style of compressor which we have been considering — the two-stage, single-acting tandem—is mostly due to the fact that the two cylinders do not each do their own exclusive work independently; and the the same objectionable conditions exist in single-acting, two-stage compressor cylinders which are placed side by side, and whose pistons are operated by two cranks at 180 degrees. The first piston, when making its compression stroke, and compressing its entire contents into the second cylinder, is helped in its work by the pressure in the smaller cylinder; and as during this stroke the cylinders are in communication, and they both have nearly a common pressure, the effective area of the first piston, when its working resistance is to be computed, is not its entire area, but only the difference of the areas of the two pistons. On the other hand, the compression and delivery stroke of the high-pressure cylinder is made without any assistance from the other cylinder.

When indicator cards are taken from the two cylinders, some engineers fall into the error of taking the inclosed area of each card and computing the power used by each cylinder from that. The total power used by the compressor, as shown by the sum of the two cards, will be correct; but the power used by each cylinder will be wrong in each case. As this matter is explained in detail in the book, I will not go into it here.

Study of Iron and Steel by Micrographic Analysis.

BY PROF. J. O. ARNOLD.
(Sheffield.)

The ever-increasing severity of engineers' specifications, framed to secure trustworthy qualities in metals used for structural purposes, has undoubtedly had the effect of stimulating metallurgists to make closer scientific investigations, having for their object the determination of the fundamental laws governing the chemical physics of metallic alloys, and the exact working of those laws with reference to the ultimate mechanical properties of metals. More particularly in connection with iron and steel, the fact is now generally recognized that materials identical in chemical composition may possess widely different mechanical properties. When the observations of the analytical chemist, although indispensable, nevertheless, became of more limited value, the metallurgical physicist appeared on the scene, and, it must be confessed, very ably put forward a theory that the otherwise inexplicable differences in the practical properties of chemically identical masses of iron or steel must be due to allotropic changes in the iron itself, and, for a time, allotropic molecules became fashionable. When, however, practical metallurgists found that the allotropic school put forward as part of their belief the startling creed that chromium and tungsten, silicon, sulphur and phos-

phorus, soften steel, it became evident that, as far as the practical applications were concerned, there was a rift in the theoretical lute, and that the indications furnished by some other line of research were destined to explain the puzzling effects frequently observed.

During the last few years it has become more and more apparent that the veil would only be lifted from the mysteries of metals by micrographic analysis—a fact of peculiar interest and encouragement to young experimenters starting along the thorny path of research. Young scientists, after executing and publishing patient and valuable work, will often find that their efforts are received with indifference. Such investigators should remember that the micrographic analysis of iron and steel was inaugurated thirty-five years ago by Dr. Sorby, in a research which, for patience of execution and sterling value of results achieved, has seldom been excelled. The sagacity of Dr. Sorby's preconceived idea, that metals should be regarded as crystallized igneous rocks, is now generally recognized. Nevertheless, practical metallurgists have only quite recently realized that Sorby's research founded the science of metallography. This science is destined in the near future to become an indispensable adjunct to chemical analysis, and it has already practically proved that the metallurgical engineer, instead of groping for the causes of abnormal mechanical effects in the outer darkness of molecular metaphysics, may often readily find such causes well within the range of actual vision by means of a cheap microscope.

In a word, the venue of trial has been changed from molecules to crystals, or, to be more strictly accurate, from molecular to intercrystalline cohesion, or, it may be, adhesion. The magnitude of this change is hardly capable of mental realization, but its enormity may be vaguely grasped by recalling Lord Kelvin's calculation of the probable approximate dimensions of a molecule, namely, that if a single drop of water be magnified up to the size of the earth, the constituent molecules of the drop would be somewhere about the size of marbles. It is encouraging to know that the growing importance of micrographic analysis has become a matter of international recognition, and among patient investigators engaged in its development in America, England, France, Germany and Holland, may be mentioned the names, respectively, of Stead, Osmond, Martens and Behrens. There is little doubt that the efforts of these and other workers will soon raise metallography to the rank of a definite science, but the path of the student seems likely to be rendered necessarily difficult by the assignation of names to apocryphal constituents, and the curse of synonyms already hovers over the science.

Many people are inclined to associate the microscopic examination of steel with a grave peering into fractures with a hand lens. It is well to clearly understand once and for all that the fracture of a piece of steel or iron has but little correlation with its ultimate structure. The latter is ascertained, firstly, by obtaining a perfectly polished section of the metal; secondly, by delicately etching with acid the prepared surface, in order to reveal the constituents, just as the structure of a macadamized road is revealed after a heavy flush of rain. The results so far obtained by this method of examination have proved that even a chemically pure metal is not a homogeneous solid, being built up of a number of primary metallic crystals, which may themselves break up into a large number of secondary crystals. It is extremely probable that the mechanical properties of such a metal are measured, not by molecular cohesion—not even by the cohesion between the secondary crystals—but by the attractive force acting between the facets and the large primary crystals.

Passing on to the question of the so-called alloys, the indications of the microscope have already gone far to negative the generally accepted idea that an alloy consists of a homogeneous solution of one metal in another, or of a non-metallic element in a metal. To take the specific case of steel in its ordinary state, as used for structural purposes, the microscope has for ever removed from the mind of the engineer any idea that he has to deal with a homogeneous mass. To bring steel into its purest and essential form, in which iron and carbon are the main constituents, the microscope has proved that steel is grown from iron by gradually increasing the carbon present, and that it reaches maturity, otherwise a comparatively homogeneous mass of true steel, when the percentage of carbon approximates 0.9 per cent. This percentage constitutes the critical microscopical point of steel, and has been named the "saturation point." The addition of more carbon produces a super-saturated steel, slowly progressing towards pig iron. However, structural engineers are more immediately concerned with unsaturated steels—that is to say, steel containing less than 0.9 per cent. of carbon. In such material, what may be called a semi-critical point of great importance, from an engineer's view, is presented in iron containing 0.45 per cent. of carbon. The material then consists of an intimate mixture of perfectly distinct crystals of iron and of true steel containing 0.9 per cent. of carbon in equal proportions. This metal presents mechanical properties intermediate between those of pure iron and true steel. Should an engineer in his specification demand a carbon higher than 0.45 per cent., he will obtain a material possessing the characteristics of steel rather than those of iron. On the other hand, in metals containing less than 0.45 per cent. of carbon, the characteristics of iron will predominate. The above statements have reference to an ideal case, the consideration of which is, however, absolutely necessary to form the base line of steel metallurgy. In practice, the case becomes complicated, because of the presence in structural steels of from 0.5 per cent. to 1 per cent. of manganese. The influence of the quantity last named on the mechanical properties of steel is well known, and its effect on the microscopic structure is remarkable. Nevertheless, it seems to have escaped the observation of most steel microscopists. There is little doubt that the observed effects are due to the formation of a remarkable triple compound of iron, manganese and carbon.

Our knowledge of this subject is far from complete; it is, in fact, a branch of the subject requiring immediate and vigorous investigation. It is, however, certain that in iron containing 1 per cent. of manganese the microscopic saturation point marking the conversion of the iron into a homogeneous compound, steel, appears about 0.65 per cent. of carbon. We have in this fact a satisfactory explanation of the well-known mechanical differences between Swedish and English Bessemer spring steel of like carbon, the kinder properties of the Swedish material being due to the fact that it contains only about ¼ per cent. of manganese. Further investigations, not yet ripe for publication, have gone far to indicate that the specific action of the elements, nickel, chromium, tungsten and silicon, are due, not to the elements *per se*, but to a remarkable series of double carbides of the respective elements with iron. The substances above mentioned are, however, often useful when employed to obtain the mechanical properties demanded by unusually severe specifications. But the steel metallurgist is confronted by the invariable presence of two elements, the action of which is always injurious, frequently to an extent seemingly out of all proportion to the percentages present. Speaking broadly, sulphur is the more deadly enemy, for reasons which open up a wide field of research in general metallurgy. The cause of the more injurious action of sulphur may be stated in a word. Sulphide of iron, which (and not sulphur) is the substance with which the engineer has to reckon, is far more fusible than phosphide of iron. The extent to which mass fragility may be produced by very small quantities of a fluid or semi-fluid constituent, after the main mass of the material has solidified, is hardly capable of exaggeration, and microscopical evidence will presently be published which will conclusively prove that proportions of sulphur hitherto deemed harmless may, under certain conditions, produce a remarkable mass weakness fully capable of accounting for mysterious and disastrous effects. Sulphide of iron is incapable of adherence to the constituents adjacent to it within the mass, so that the extent of

its injurious effects will depend upon the form in which it exists mechanically. Its least injurious form is that of fused globules, which are practically equivalent to minute blowholes. Its most dangerous form is that of attenuated membranes enveloping groups of crystals, and forming long lines of weakness equivalent to minute cracks. The mechanical distribution of the semi-fluid sulphide during the rolling and hammering of steel, presents dangerous possibilities and requires rigorous microscopical investigation.

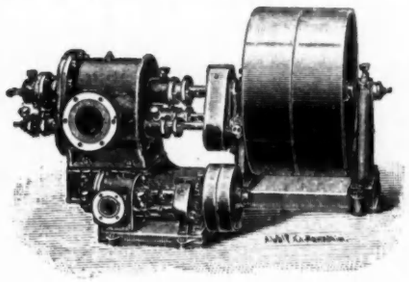
A fruitful field of research which has already yielded important results is the microscopical determination of the changes taking place during annealing. The constituents chiefly involved in this change are the carbides and sulphides, and the results already obtained have completely negatived the accuracy of the generally accepted theory of annealing. It is not intended in the present article to anticipate, by premature publication, the remarkable influence of annealing on the distribution of sulphide of iron, and the increase in mechanical strength following such redistribution. With reference to carbides, however, it may be pointed out that in one of our leading textbooks on metallurgy the toughening influence of the process of annealing is attributed to three causes: 1. A change of hardening carbon into carbide carbon. 2. A breaking up of large crystals into minute crystals. 3. A distribution of carbide carbon from crystalline pellets into finely-diffused particles. Micrographic analysis has shown that not only are the foregoing statements inaccurate, but they are also opposed to fact, for the following reasons: 1. There is no hardening carbon in steel castings. 2. The crystals become much larger on annealing. 3. The carbide carbon is entirely concentrated into crystalline pellets. The above case is a single example of the light destined to be thrown on the metallurgy of steel by micrographic analysis. It, however, yet remains for engineers to fully grasp the realities briefly set forth in this article. To do so, it is necessary to examine a comprehensive collection of properly prepared iron and steel microsections. The recognition of the value of the science to metallurgical engineers has undoubtedly been retarded by a pedantic adherence to the reproduction of the structures observed by photography.

It seems that the idea that the camera is the George Washington of inanimate life has not yet been exploded. As a matter of fact, there is only one philosophical instrument capable of conveying more inaccurate impressions than the camera, and that is the gas meter. Anyone who is familiar with the actual structures of steel, and with the foggy series of photographs published from time to time to represent them, will admit the accuracy of the above statement. The technical difficulties involved in photographically reproducing the micro-structure of opaque objects under high powers are so great, that at present the only reliable means of reproduction is laborious hand drawing, employing either a micrometer or camera lucida; and the only reasonable objection to such a course is an imputation of *mala fides* to the operator.

For obvious reasons, the structure of iron and steel has herein received most attention, but micrographic analysis is capable of application to many alloys, and of explaining not only their mechanical properties, but also their electrical conductivities, so that the science is of importance, not only in practical metallurgy, but also in theoretical physics, based on observations of the electrical properties of alloys.—"Iron and Coal Trades Review."

A Tri-Axial Rotary Pump.

The accompanying illustrations show a reversible rotary pump, of the Klein system, having three axes, and involving points of great advantage as compared with many other other machines of this class. The following description is translated from the "Revue Industrielle," Paris:



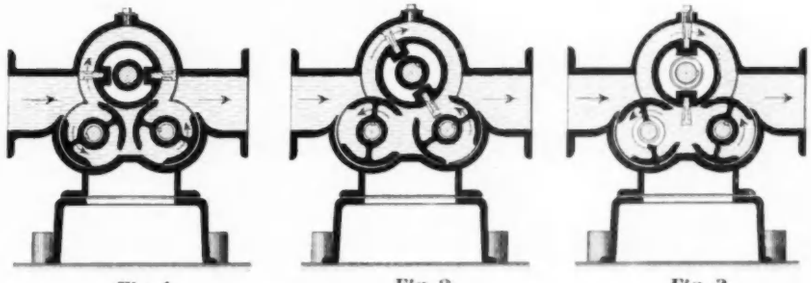


Fig. 1 *Fig. 2* *Fig. 3*

American Machinist

TRI-AXIAL PUMP.

Of the three rollers which revolve at the same speed in the cylinder of the pump, two are cut out on either side, so as to leave two segments diametrally opposite; while the third roller is hollow, but with its periphery entire and provided with two radial blades. The transverse section of the interior of the shell comprises portions of three equal circles, cut by the suction and escape-pipe orifices. The shafts of the three rollers are driven by spur wheels inclosed in a protective casing.

An examination of Figs. 1, 2 and 3 will show the operation of the pump. The three phases represented correspond to a quarter turn of the rollers, and are reproduced symmetrically in every revolution. There is always a contact of the surfaces of the rollers, to separate the suction from the forcing action.

This pump is interesting, because not only do its members turn with the same angular velocity, but the rolling takes place only between surfaces of the same circumferential speed; and herein lies the quality of durability in good working condition, which is not found in certain pumps of two axes, where the wings of one roller rub against the shell much less than the other roller, and vice versa. There results from such an action a friction which, in addition to the loss of useful energy, tends to wear the members and, as the closeness of contacts diminishes, gradually to lessen the efficiency. These difficulties seem to be avoided in the Klein pump, because of the absolute equality of the circumferential velocity of the rolling surfaces; for the blades of the upper roller come in contact only with the wall of the upper cylinder, and at exit therefrom pass into the open spaces between the segments of the lower rollers. These spaces are so large that there is no danger of an interference from a slight deviation, due either to irregularity of wear on the rollers or to a blow, which is a matter of considerable importance.

These pumps are designed for pumping to elevations of one hundred feet or less. They are adapted to liquids either cold, hot or sirupy, and may also be used as blast machines. They turn at moderate speeds and yield a good efficiency.

Near Manchester, England, a large chimney was recently taken down in a rather novel way. The chimney was octagonal, 270 feet high, 27 feet in diameter, and was estimated to weigh 4,000 tons. A street of cottages was close to it on the north, and a vacant field on the south, so that it was necessary to control the direction of its fall. One-half of the base was cut away on the south side, the structure being supported temporarily by strong timbers and uprights. The timbers, when all was ready, were saturated with paraffin and set on fire, burning so fiercely that in six minutes, after a preliminary lurch, the chimney gradually telescoped downward, falling within a very limited area.

ELECTRICAL MACHINERY.

Electrotechnics—X.

The Principles of Electricity for Practical Men.

BY FRANK S. MASON.

24. SATURATION. The rapid drop in the value of μ, coincident with the increase of the magneto-motive force, as represented by H, shown by the tables given last week, indicates the fact that, as noted in § 19, there is a point beyond which the result (B) does not justify the expenditure of the amount of additional energy required; or, in other words, further additions to the ampere turns. This point varies from B equal to ten thousand to twelve thousand for cast iron, to B equal to sixteen thousand to twenty thousand for wrought iron.

The case is exactly parallel with the overcrowding of a steam pipe to a point where the drop in pressure is excessive, or with an electric conductor pushed beyond its safe capacity to a point at which an undesirable or a dangerous degree of heat is developed.

On the other hand, if a steam pipe is of a size greatly in excess of what is needed, there is a waste of material and an amount of money lying idle to no purpose. So, also, with the electric circuit, and the magnetic circuit as well.

The clearest and most impressive manner of determining in any case where the limit of useful saturation of a given iron or steel is to be found, is to plot out a line on cross-section paper from figures such as are given in the tables to which reference has been made. The diagram Fig. 31 is laid out from Tables II and III.

In this diagram the line $O\,H$ represents the magneto-motive force, and line $O\,B$ represents the magnetic flux. The points in the curve are determined by projecting upward from the former and outward from the latter corresponding values, to a point of intersection. For instance, take the figures quoted for finding the value of μ in § 23. Upward from five in $O\,H$ and outward from four thousand in $O\,B$, gives point a in the line for gray cast iron; or upward from five to outward from ten thousand in $O\,B$, gives point b in the line for annealed wrought iron. And so we may proceed until an entire curve has been plotted.

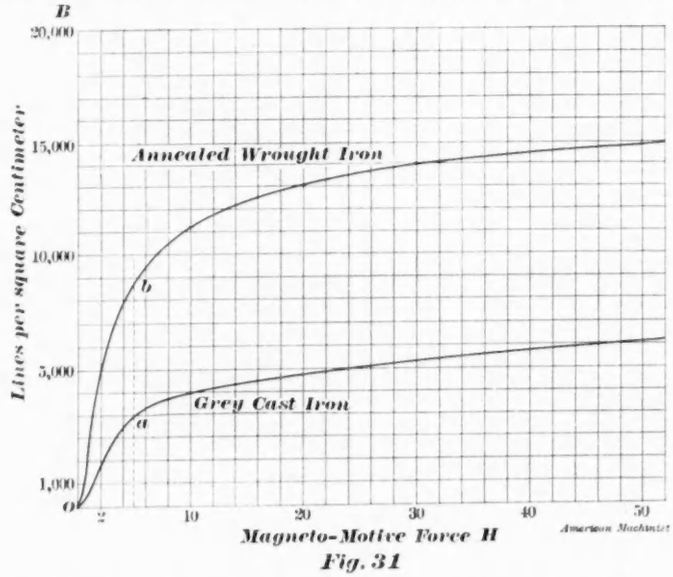


Fig. 31

From this diagram it will be seen that from the initial point the magnetization of the iron lags a trifle. Then the value of B rises rapidly with each addition to the magneto-motive force, followed by a somewhat abrupt bend toward a horizontal direction as the iron approaches saturation, and from the bend of the curve onward the line rises but very gradually; showing at a glance that to push the magnetization much beyond the bend of the curve is a waste of energy.

This fact is still more clearly developed in the exaggerated diagram shown in Fig. 32, in which the curve $O\,a$ represents the magnetic flux through an iron core, and the line $O\,b$ represents the magnetic flux due to the same magneto-motive force acting on air only; that is to say, with the iron core removed. But the most impressive and instructive feature of the diagram is the line $O\,c$, which is the line $O\,a$ minus $O\,b$, and is plotted by setting off points downward from $O\,a$ to distances equal to the altitude of corresponding points in the line $O\,b$, directly below. The line $O\,c$ therefore represents the actual increase in the magnetic flux due to the presence of the iron. Observe that beyond the bend of the curve the line is straight, and the rise is very slight—so slight, indeed, as to be very nearly horizontal. This fact emphasizes the saturated condition of the iron very distinctly. It is considered that if it were possible to push the magnetization far enough, the lines $O\,b$ and $O\,c$ would meet, the permeability of the air being then equal to that of the saturated iron, in which case the value of μ for the iron core would be two, not one, as might appear at first thought, since we have to add the altitude of $O\,c$ to that of $O\,b$ in order to obtain $O\,a$, the total magnetic flux B in iron.

The lines in the diagram shown in Fig. 33 illustrate graphically the decrease in the value of μ with the increase of the magnetic flux. Beginning at a with μ equal to three thousand and B equal to five thousand (for wrought iron), the value decreases to μ equal to thirty as the value of B rises to twenty thousand at b; while for cast iron, beginning at c with μ equal to eight hundred and B equal to four thousand, the value of μ decreases to thirty-seven as the value of B rises to eleven thousand at d. This diagram also is laid out from Tables II and III, where it will be found that the values at a are based on a mag-

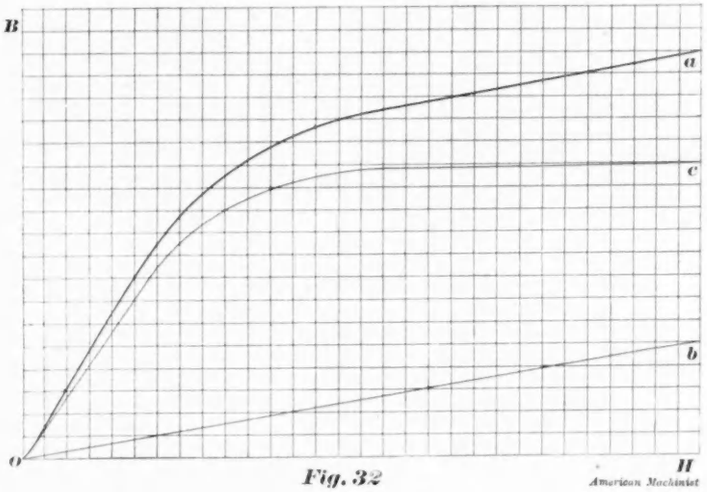


Fig. 32

neto-motive force H of 1.66, and at b of 666, in Table III for annealed wrought iron. Again, the values at c are based on a magneto-motive force of $H = 5$, and at d of $H = 292$, in Table II for gray cast iron.

Comparing Figs. 31 and 33, it will be observed that, coincident with the rapid relative increase in the magnetic flux up to the point of saturation, as represented by B compared with H in Fig. 31, there is a rapid decrease in the permeability to the same point as represented by μ compared with B in Fig. 33; while beyond the point of saturation, the value of B compared with H in Fig. 31 rises slowly, and the value of μ compared with B in Fig. 33 decreases with corresponding slowness from the same point. This effect may perhaps be more clearly seen if Fig. 33 is stood on end, with the line B toward the observer, when the line representing, for instance, annealed wrought iron may be considered as "dropping" from a to b.

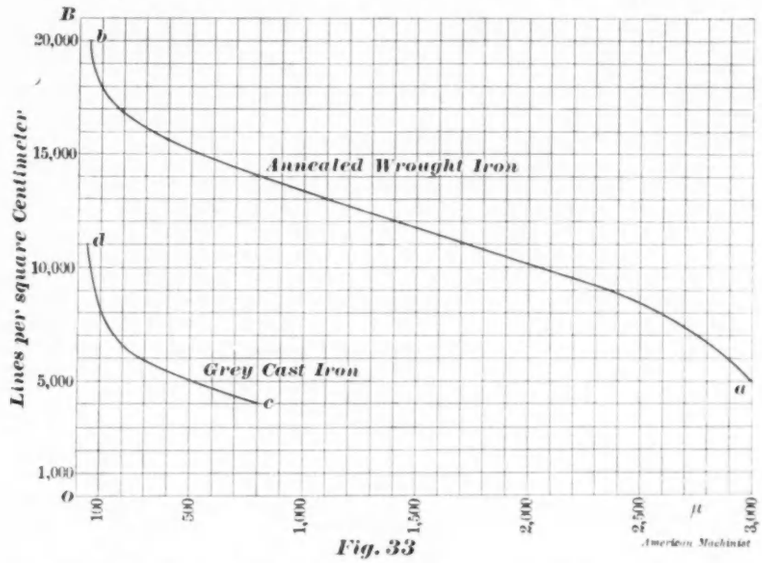


Fig. 33

It should be remembered that the value μ is obtained by dividing B by H; and referring to Tables II and III again, it will be found that if the figures in column B are divided by those in column H, the result will give the figures in column μ; or, if μ and H are multiplied together, the result will be B.

The Thomson-Houston Co., of New Haven, Conn., have brought suit against the Kelsey Electrical Specialty Co., of New Haven, Conn., and the Billings & Spencer Co., of Hartford, Conn., to restrain them from manufacturing the overhead trolley bar, the Thomson-Houston Co. claiming that it has patents which give it the exclusive right to manufacture these bars.

One of the conspicuous things about the American electrical press, is the unanimity with which each insists itself to be the youngest of the fraternity.

The Relative Merits of Drum and Ring Armatures, Considered from the Standpoint of the Users of Electrical Machinery.

BY WM. BAXTER, JR.

In Two Parts—Part II.

Figs. 1 and 2 are simple diagrams showing the way in which wire is wound on drum and ring armatures, respectively. Fig. 1 shows three pairs of coils, and Fig. 2 two coils. In both figures the coils are shown separated, to more readily illustrate the method of winding; but it will of course, be understood that in a finished armature the whole surface is covered. It might appear at first sight, that, as in both styles of armature the whole surface is covered, that portion of the wire that is on the periphery would be equally well secured in both cases. But this is not so. By looking at Fig. 2 it will seen that the wires in coils a and b run side by side throughout their entire length; therefore, they can be placed so that there will be no vacant space between them. A similar inspection of Fig 1 will show that the coils, where they pass over the ends of the armature, do not run side by side. Now, if we imagine coil a to be as near to coil b as possible, we will see that as b must bend and pass over a, a certain amount of space must be left between the two, unless we make a very sharp bend in b—much sharper than would be allowable in practice.

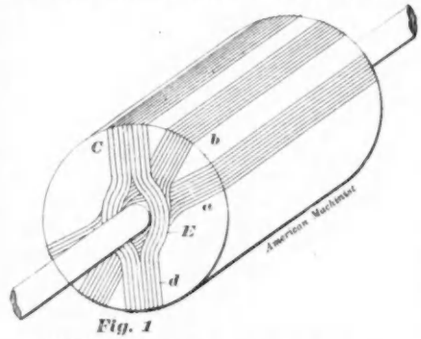


Fig. 1

WINDING OF DRUM ARMATURE.

From this cause alone we can see that there would be more chance for the wire on the periphery of the drum armature to become loose than there would be with the ring armature. This difference does not amount to very much, however, because the space between the sections can be filled in with insulating material, so as to greatly reduce the chance for vibration. But when we come to consider the condition of the wires over the ends of the two styles of armature, we will at once see that the ring is decidedly the best. In the latter type of armature the wire is held in place just as securely on the ends and on the inside of the ring as upon the periphery, the wires being practically parallel with each other throughout their entire length. With the drum construction this is not the case, because over the ends the wires cross each other; therefore, the space they occupy is not filled in solid, but is interspersed with numerous cavities. As a result, the mass of wire at each end of the armature is in a somewhat yielding condition.

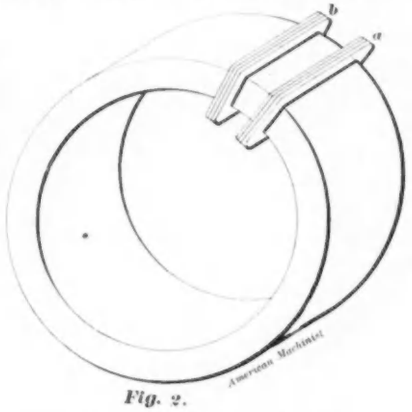


Fig. 2.

WINDING OF RING ARMATURE.

By looking at Fig. 1 it will be seen that the sides E of coils C will have a tendency to move away from the center of the shaft, under the strain impressed by centrifugal force. In addition to this, the magnetism of the field will exert a force at the point d to displace the wire sidewise. Under these two strains, it is evident, that if there is any slackness in the wire a certain amount of movement will take place. To obviate this trouble, great care is taken, in winding drum armatures, to have the wire drawn as tightly as possible without injury to the insulation, and at the same time to run it along the path that will make the shortest distance from one side of the armature to the other; but with all the care that can be exercised, it is evident that where so many wires cross each other, some may be left loose. If any of the wires vibrate while the machine is in motion, the insulation will be chafed, and

in time will be worn away sufficiently to allow the bare wires to come in contact. When that occurs, a certain number of coils will be short-circuited, and an enormous current will be generated that will, in a very few seconds, heat the wire to a temperature high enough to burn the insulation. To guard as far as possible against such troubles, strong insulating cloth is placed between the different coils where they cross each other. This puts off the day of reckoning, but does not remove the weakness of this style of construction.

It is evident from the foregoing that, in the ring armature, the insulation is not subjected to as great a strain as in the drum type; therefore, if the same skill and care are used in the construction of both, the former should be the most durable.

Although this conclusion is true, we can also say, that if good judgment is used in designing a drum armature, a structure may be produced that will be very nearly if not fully as durable as the ring. To accomplish this result, it is necessary to not wind too much wire on the armature. Most designers like to use all the wire possible, because it enables them to obtain a large output from a small machine. But this advantage is obtained by sacrificing durability.

In order to obtain a thoroughly substantial construction the cross-sectional area of the wire on the periphery of the armature should not be over twenty-five per cent. of the cross-section of the armature core for diameters under eight or nine inches, and in larger sizes the percentage should be still less. As an example, an armature five inches diameter outside should have a core four and a half inches diameter. This would make the space occupied by the wire a little less than twenty-four per cent. of cross-section of core. Thus:

Outside dia., 5 inches = 19.64 inches area.
Core " 4½ " = 15.90 " "
Difference, 3.74 "

$$\frac{3.74}{15.90} = 23. + \text{per cent.}$$

Figs. 3 and 4 illustrate the difference between an armature wound with a small amount of wire, and another in which the amount is so great as to render substantial construction impossible. In Fig. 3 the difference between the diameter of the core *d* and the outside of the wire *E*, is such that the space taken up by the wire is less than twenty-five per cent. of the cross-section of the core. In Fig. 4 the wire takes up about double this space. In Fig. 3 it will be noticed that the line *a*, which represents the outside of the wire over the end of the armature, is a much flatter curve than the same line in Fig. 4. It will also be noticed that the wires of coil *b* in Fig. 3 cannot be thrown very far from the center, if at all, by the action of centrifugal force, because they would have to move on the curve *c*, and would therefore at once press against the wires underneath and go no further. But in Fig. 4 the case would be very different; the curve *c* is outside the line *a*; therefore, the more the coil *b* moves away from the center, the looser it will get.

From these two illustrations it will be seen that, if an armature is constructed as shown in Fig. 3, the movement of the wires running over the ends will be practically nothing; but if constructed as in Fig. 4, there can be a great deal of movement, as the only thing to hold the wires

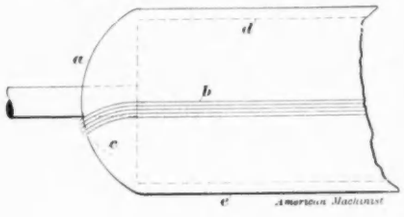


Fig. 3

MODERATE AMOUNT OF WIRE.

in place is their own stiffness. Hence, such an armature would soon give out.

All things considered, ring armatures should be the most durable, and no doubt are; but drum armatures, if properly proportioned and well constructed, may be depended upon to give good service. The durability of an armature, however, is not the only question of importance; the cost of and time required to make repairs when a burn-out does occur, are also questions of importance; and in these respects the ring has a decided advantage. When an armature short-circuits, it seldom burns out more than two or three coils. If it is of the ring type the coils can be readily removed and new ones wound in their places, and if the workman is sufficiently skilled he will not have to disconnect the commutator to make the repairs; therefore, the cost of replacing the damaged coils will be small. With a drum armature the case is quite different. The burned-out coils may be among the outside or the inside ones, but the chances are that they will be midway between the ends; therefore, to repair the damage, the commutator will have to be disconnected and removed, and one-half of the armature wire taken off and rewound. This will involve an expenditure equal to more than half the cost of rewinding and connecting the whole armature, and will in all probability be four or five times as much as the cost of the same repairs to a ring armature.

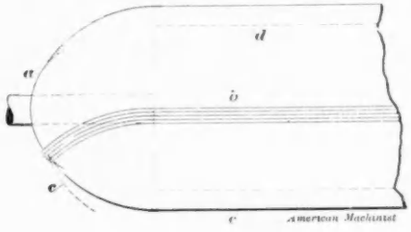


Fig. 4

EXCESSIVE AMOUNT OF WIRE.

In summing up we can say, therefore, that the ring armature is the most desirable, because it is not so liable to give out; and if it does, the cost of repairing will be less than for a drum armature, and the time lost on account of the damage will be less, as a ring armature may be put in service as soon as the repairs are made, while a drum armature should be allowed to stand for several days, so that the insulating varnish may become thoroughly dry and hard. If the armature is started before it is dry, the wires may shift under the strain of centrifugal force, and furthermore, the liquid in the varnish, in most cases, is of low enough resistance to allow the current to break through the insulation and burn out the coils, thus rendering it necessary to make the repairs over a second time.

LETTERS FROM PRACTICAL MEN.

The Kane-Pennington Motor.

Editor American Machinist:

I do not wish to "hit a man when he is down," but I do wish to help this Kane-Pennington-Randol *et. al.* matter, so that in the long run the public may as clearly and correctly as possible understand the mysterious mechanical witchcraft by means of which an inventor (?) can produce unheard-of economic results by going backward.

Having examined the Kane-Pennington engine (more than once), and having seen and examined the motor bicycle, running, both on the ground and suspended in air, I am free to confess that I was not only surprised, but shocked, when I read Mr. Randol's first article in your valuable paper. To my mind, it was astonishing that a writer for a reliable technical journal should soberly rush into print—in our analytical era—with such vigorously-drawn claims about the "mysterious" and "miraculous" properties of a most primitive combination of poppet-valve, piston, cylinder and igniter, and grandly waive the opportunity (tendered) for examining certain slips of paper, purporting to be diagrams which would sustain his claims.

Of course, I would not charge him with the plebeian practice of ordinary intoxication, but only that he was deeply under the influence of a certain intoxicant, which many people in the West will recognize the nature of when I refer to it as the "Elixir Hypnotique à Pennington."

The greatest stumbling-block in the way of a certain class of inventors who are ever prolific in schemes for revolutionizing all (settled or unsettled) industries, is the blinding mixture of hope and faith that they can in the mechanical world get something for nothing. When a man believes he can produce, or that his friend

can produce dynamic energy, without sacrificing its full equivalent of some other form of energy, his shins are abreast of that stumbling-block; and if he does not receive a little wholesome light, he will hit it sure, and the block will not be the one to suffer in the collision.

Now, I do not wish to criticise the inventor of the Kane-Pennington engine; he did his best, of course. Indeed, he showed great sagacity in making his engine light when he didn't want it heavy. All I wish to point out is, that his engine must not be expected to do what it is not made to do. If I mistake in the following items, I shall be much obliged to Mr. Randol if he will set me right:

1st. The engine has no provision for automatically gaging the amount of fuel consumed to the amount of work done, but has a little throttling needle valve to be regulated by hand, à la gasoline stove. Result: Great wastefulness, great irregularity of motion, great and unavoidable discharge of unconsumed carbon; hence, unpleasant odor.

2d. It has no means provided for governing its speed; therefore it is incomplete, since it must constantly be under the eye of an attendent where any degree of regularity of motion is required.

3d. It makes four sparks in two revolutions and wastes three of them; therefore is certain to lack economy in the use of electricity.

4th. It wears its electrodes three times as fast as it should; and as I believe no "mysterious" or "miraculous" substance is available in it for electrodes which is denied to other makers of engines, "simplicity" in that case is not dearly purchased.

5th. Is it not a fact that in all weights of the engine given (17½ pounds, etc.) the balance wheel and frame have been left out of the computation, and only the cylinder, piston, valves and connections given?

6th. Will anyone, who knows what he is talking about, claim that from 500 to 750 explosions per minute can take place in any thin metal cylinder without so heating it as to cause its destruction, where no means other than the naked cylinder walls are provided to carry off the heat absorbed from the exploding gases?—it being borne in mind that the maximum temperature of the explosion is near the melting point of platinum, and repeated from eight to fourteen times per second. This would have to be done to generate the full power of an engine at 1,000 revolutions and 1,500, respectively.

C. C. HILL.

Chicago, Ill.

A New Split Die.

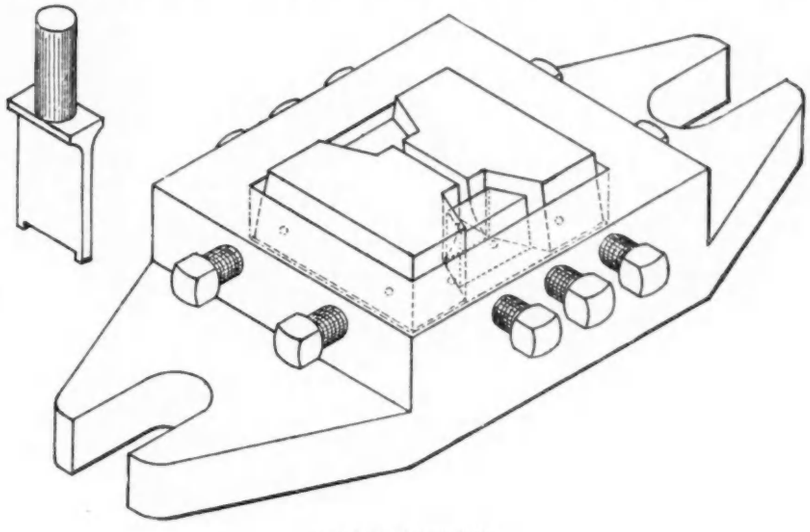
Editor American Machinist:

It may be interesting to some readers of the "American Machinist" to see a peculiar form of a split die, which, although designed and made by me for a special purpose, can in principle be applied in other cases where similar cutting has to be done.

The above-mentioned special purpose was to cut off flat steel-wire strips, such as are used for dress stays; the chief requirement was the production of absolutely clean, burrless ends on the strips.

The dies used before were of the common, solid block type; but as the cutting edges wore out rapidly in use, the die was spoiled in a short time, making ragged ends on the strips. The illustration shows the die as now in use, and, as it has given satisfaction for more than a year, I think it worth describing.

The two die halves are placed in a rectangular recess of a cast-iron bolster, and held firmly down and together by set screws bearing upon the beveled sides.



A NEW SPLIT DIE.

Two wedge pieces fit the sides of the angular recesses between the die halves, and are forced in or released by set screws. The figure shows in full outline the location of one of the wedge pieces.

Now, it will be readily seen that, on taking out the die halves, the sides of the cutting edges may be ground, and after the die halves are replaced in the bolster or shoe, by means of set screws and adjusting wedge pieces, a perfect punch fit can be restored again. Lugs upon the cutting end of the punch serve as guides; they enter the die before the act of cutting takes place.

As the wire that is cut is ⅛ inch wide, the die furnishes about six fresh cutting divisions before another grinding is necessary. A movable guide plate, resting upon the die and screwed down to the bolster, is provided for the wire to slide in.

The die is mounted on a foot press; a girl operating it being able to cut off pieces of 6 to 10 inches length from coiled wire at the rate of 150 to 200 in a minute.

Set screws, however, would not insure sufficient stability for heavy cutting; wedges or other means must be employed to secure the die halves firmly.

New York. FRANK HERLT.

Setting Angle Plate.

Editor American Machinist:

I am glad to see Mr. Watson has shown (February 20th issue) another way to do this job, as it is an advantage to know of all the different ways, so one can choose the method adapted to the facilities at his command, or that will come within the limits of accuracy which he wishes to attain.

Mr. Watson's method would probably appeal to nearly all lathemen, as it involves nothing except what can be obtained in any shop that uses a lathe, besides being, as he says, quicker than mine; but I could not have applied it, because my lathe, as furnished by the makers, does not admit of the large face plate and live center being used at the same time. On the other hand, the accuracy of the second lot of Mr. Watson's pieces would depend on the truth of the live center, the truth of the arbor, and also on the alignment of the lathe; none of these factors having any effect in the method I described. What I was after more particularly, was some way in which the angle plate could be set off center to some predetermined distance by micrometer measurement; but, of course, both methods are on a par in this respect, as Mr. Watson could put a disk on his arbor and turn it to a given diameter, which could be accurately and conveniently measured, and could then shove his angle plate against this to locate it.

WALTER GRIBBEN.

Brooklyn, N. Y.

Working Conditions of Hub Tools.

Editor American Machinist:

Yours of the 25th instant has been received.

The cutting speed was 60 revolutions

per minutes, and bar of stock $1\frac{1}{16}$ inches diameter, turned down to $\frac{7}{32}$ inch at its smallest diameter. The tools were fed from a 2-pitch single worm, making 45 revolutions per minute, into a 40-tooth worm wheel, thence through a 6-pitch single screw direct to the tool holder. The lubricant used was pure leaf lard oil, supplied in a liberal manner, so that the tools and stock were entirely flooded.

Trusting this will supply the information desired, I am,

GEO. G. PRENTICE.
Supt. Windle Cycle Co.

Worcester, Mass.

[The above refers to the tools for making hubs referred to in Mr. Randol's article, published last week.—Ed.]

The Designer of Improved Punching Machines.

Editor American Machinist:

In reading your article upon "Bicycle Tools," in your February 20th issue, I notice that upon page 205 you show a box-frame punching press in Fig. 111, which you speak of as being "well designed." You fail to say, however, as doubtless you did not know, that this general form is copied from the punching presses which I designed about twelve years ago (in place of the ribbed ones then prevalent), and which were then new in the market, although they have since been copied a number of times, both here and abroad. A distinguishing feature of these was the belt fly-wheel with the pinion forming an extension of its hub, running upon a stud, upon which also ran the adjacent loose pulley. This system was made a success by the carefully-arranged proportions of the stud, and its anchorage in the frame with a view to getting sufficient stiffness without employing the outboard bearing, which had previously been so much used. I inclose circular dated June 1, 1885, showing my original design. The machine had, however, been built a year or two earlier.

You speak also of the "globe-end" pitman as being the most desirable style of adjustable connecting rod. This you will find, was patented by me May 4, 1886, No. 341,353, claim 5 broadly covering it. It since has been developed into extensive use by the Ferracute Machine Company, during several years, and by means of numerous experiments to ascertain correct proportions. I make these explanations knowing that you will wish to give credit for design where it is due.

OBERLIN SMITH.

Bridgeton, N. J.

A Well-Equipped Draftsman.

Editor American Machinist:

Although rather late, I wish to reply to Mr. Tecumseh Swift in January 23d "American Machinist," regarding triangles. I use not only a third triangle, but have, and frequently use, 5, 10, 15, 20, 22½, 25, 27½, 30, 35, 40, 45 degrees (eleven in all), which give about all the angles desirable without using two or more pieces. I also have a very complete set of batten angles, varying by 1-16 inch up to 1 inch, and by ¼ inch to 12 inches; i. e., 1-16 inch in 12 inches, ¼ inch in 12 inches, etc. I use in connection with these a board with all these angles marked on, so that I can readily set an angle T-square if desired. I also use angle T-squares with double heads, so that by simply turning upside down I get angles both directions from center; this is very convenient for a great deal of work.

I keep and file the "American Machinist" in a cabinet just the size of the paper, and put a movable board shelf between each year's number, and keep the entire indexes in one of the "handy binders," which gives me a chance to examine all the indexes and refer to any paper in the cabinet without handling the whole year's volume.

Thanks for the change in "American Machinist"; it is a decided improvement over the old form.

EZRA ESTEP.

Sandwich, Ill.

Cross-Section Paper in the Shop.

Editor American Machinist:

I am very glad to see that the many uses of cross-section paper in the shop and drawing room are beginning to attract attention in your columns.

Mr. W. O. Webber opened up its use in connection with shop sketches, in your issue of March 5th, but more may profitably be said in that direction.

I have found the systematic use of such paper for shop sketches one of the greatest labor savers and equalizers, as well as work expediters, that I know of. In many lines of work the drawing office, like the pattern shop, is in a chronic state of feast or famine. A new size or style of machine has been sold for quick delivery; everything is at a standstill until the drawings are out, and high pressure doesn't describe the state of things in the drawing office.

These cross-section paper sketches may be made in a fraction of the time required for drawing, tracing and blueprinting, and they can be used with entire satisfaction for a surprisingly large number of details. A scale, compass, and Eagle copying pencil, with a pad of cross-section paper, complete the draftsman's outfit for the work. A copy press keeps a record for office use; and when the pressure is over and the draftsmen are asking for something to do, the copy book may be gotten out and, supposing the machine to be intended for an addition to the regular line of product, the sketches may be put in permanent shape by being repeated in drawing and tracing. The use of the paper thus serves to both cut down the hills and fill up the valleys, and thus makes the work of the drawing room much more uniform.

Regular lithographed cross-section paper, as sold by the instrument dealers, is, however, rather expensive for this kind of work. I have found an effective and cheap substitute in common writing paper, ruled by the stationer into ¼-inch squares. Such paper will not, of course, be of the refined accuracy of the regular cross-section paper, but it answers such purposes just as well. It is cheap enough to be used freely, and can be ordered in pads, thereby increasing its convenience.

C. K. JACKSON.

Testing Injectors.

Editor American Machinist:

In your issue of January 23d, the article on "Testing an Injector," by W. H. Wakeman, contains an error, which, though perhaps unimportant, should, I think, be corrected for two reasons—the high authority which your paper is on all such matters, and the fact that the article is written for the purpose of instruction:

When testing an injector raising water from the tank, the weight of water was that fed to the injector.

When testing the injector supplied with water under 25 pounds pressure, the water that was weighed was the water fed to the injector increased by the weight of steam used by the injector.

The error lies in the fact that in one case the steam used by the injector was weighed, in the other case it was not.

In an ordinary single-tube injector, the proportion of steam used to water entering the injector is very nearly 1 to 14. Therefore, the weight of water in the barrel when the injector was taking water under pressure should be diminished by one-fifteenth, or 6⅔ per cent. This would change Mr. Wakeman's figure, for the increase of feed due to taking water under pressure, to $22\frac{1}{2} - 6\frac{2}{3}\% = 15\frac{1}{3}\%$.

As a check to the above calculation, I add the following, which may prove of value to some of your readers, as by means of it the increase of capacity due to any such change as that tested by Mr. W. may be calculated. The formula used is from Pochet's "Steam Injectors," published by D. Van Nostrand:

$$V\left(V - \frac{v}{1+y}\right) = \frac{(P-p)g}{62.4}$$

in which

V = velocity in feet per pound of mixture of water and steam entering the divergent (or second) tube of the injector;

v = velocity in feet per pound of steam entering injector;

y = pounds of water entering injector per pound of steam entering injector;

P = pressure per square foot of water entering injector;

p, for an ordinary single tube injector, equals the pressure of the atmosphere in pounds per square foot;

g = force of gravity = 32.2.

Applying this formula to our two cases, we have :

Case I.—Injector drawing water from tank : Lift = 2 feet.

In this case, $P = p$

$$\therefore \quad V\left(V - \frac{v}{1+y}\right) = o$$

$$V = \frac{v}{1+y}$$

We have $v = 1446.5$ ("Kent," page 668.)

$$y = 14$$

$$\therefore \quad V = 96.4$$

Case II.—Injector receiving water under a pressure of 25 pounds per square inch. We have v the same as in Case I, since 25 pounds is less the three-fifths of the boiler pressure (70 pounds) ; y is assumed to be the same ; $P = 5.760$; $p = 2,160$. The formula then is :

$$V(v - 96.4) = \frac{3600 \times 32.2}{62.4}$$

$$V^2 - 96.4\ V = 1857.7$$

$$V = 113$$

We have found then :

In Case I.—$V = 96.4$

In Case II.—$V = 113$

—or an increase of 17.2 per cent. for the case of the water being delivered to the injector under pressure.

The figure found by Mr. Wakeman has been shown to be 15⅓ per cent., showing an agreement of within 2 per cent. If we had taken $y = 13$, instead of 14, the calculation would have given 15 per cent.—a result identical with Mr. Wakeman's.

The weak point in the above calculation is that y is assumed to be the same in both cases. Mr. Wakeman's experiment shows roughly that this is true.

In conclusion, Mr. Wakeman's test would have been practically correct if he had used in both cases the method employed in the second case. Instead of using a weighted safety valve, a simple globe valve between the gage and the barrel into which the injector is delivering is all that is necessary. After the injector has started, this valve is closed until the gage stands at the boiler pressure.

Hoping that you will pardon the length of this letter, and that it may prove of some value to your readers, I am,

CHARLES P. PAULDING.

Calumet, Mich.

Admission Requirements in Engineering Schools—The Apprenticeship System.

Editor American Machinist:

I was very glad to see, in the issue of the "American Machinist" for February 13th, two articles — one referring to Lehigh University, at South Bethlehem, Pa., and the other on "High Admission Requirements in Engineering Schools." Both of these articles emphasize a point that I think deserves a great deal of attention; that is, that most of our technical schools are out of reach of the poor boy, who largely supports himself, and that they tend to turn out a class of graduates who are crammed full of principles, but know almost nothing of practice, or of the application of principles to practice. My own experience has been that, for assistants, I much prefer those young men who have spent three years in a regular machine shop, and then had a year or two in a technical school where they were allowed to study just what their previous practice had shown them that they would need most in actual life, to those who have graduated with a fine theoretical thesis from one of the high-grade technological institutes, with no shop practice whatever.

It always seemed to me that our Polytechnic Institute at Worcester, Mass., was more nearly on the right track than some others. Here is a technical school making something commercially for sale, with the boys at work, at small wages, making these things, and at the same time studying the principles of the things on which they are actually working, and so more fully fixing both in their memory.

Whenever I have had charge of large manufacturing plants (and this has been for most of my time during the past twenty years), I have endeavored to carry out a certain policy, and it has always resulted very satisfactorily. It has been to get good bright boys to sign for and serve a three or four years' term of apprenticeship at one of the many trades being carried on in such a place, i. e., the machinist's, pattern maker's, molder's, blacksmith's or carpenter's. If the boy proved bright and intelligent, and, above all, eager and willing to push himself ahead, some time during his third year I took him out of the shop and put him into the drafting room for six or nine months, during which time he was taught how to make drawings, what drawings were made for, and what ideas they were intended to convey. He was given a simple, plain geometry, and told to study that part referring to plane surfaces. He was then taught to design simple pieces, and especially those referring to jigs and shop appliances and work, and finally he went back to the shop again to complete his time, with his ideas broadened and his mind brightened by what he had seen in the drawing room. Now, if he was, say, a machinist, he was allowed to take indicator cards and assist in adjusting engines on the test blocks, including those with automatic shaft governors, to assist in making evaporation boiler tests, and, in fact, given a good chance in practical steam engineering, and finally, if he was unusually bright, was sent to nearby towns, at first in company with an older expert engineer and then by himself, to "doctor" or adjust a "sick" engine. And I must confess, myself, to having been surprised at the development of some of my boys. One of them now, after fully five years in the shop and drawing room, is taking a special course at Tuft's College in applied mechanics, calculus, etc., this seeming to be about the only school he could find where he could study just what he wanted without passing an examination in or having to study a lot of subjects in which he had not so much interest, and to which he could not afford to give his time.

Other boys, as those in the foundry, after two years, were given a time in the drawing room and a short time in the pattern shop, and then went back to the foundry and were put on as "melter's helpers" on the cupola, where they were required to keep track of the charging of the cupola, the mixing of the iron and fuel, and charging "the heat," to cast the test pieces from the different grades of the melting, and the next day to take these pieces over to the laboratory and test them in the testing machine.

We always gave the preference in selecting these boys as follows: First to the sons of foremen, then to those of old and faithful workmen, then to nephews and relatives of the above, and finally to outsiders, making it as a requisite that none should come in as a full apprentice except those of seventeen years of age and having a good grammar-school education, with the ability to read and write a good hand and figure easily as far as proportion. We were always overrun with applications, names being on the books a year in advance, awaiting their turn. These boys were regularly indentured, signing papers with parents or guardians, and it was in every way a success.

If I were asked to-day which I would advise a young man to do, who aspired to fit himself for the engineering profession—go to a technical school, or enter a machine shop and learn the trade first—I should unhesitatingly tell him to do the latter, as I believe that the habits of concentration and observation then and there acquired are of incalculable benefit to him in after life, as well as when he comes to go into the technical school after his shop season is done. He then knows what he wants to study and why he wants to study it, and, I believe, has far more earnest application than he ever had before. I do not think that the point made by some professors, that the three or four years of shop life unfit the boy for study, is well taken. I went to evening drawing school, and to algebra and geometry classes, all during my apprenticeship, and am not ashamed to confess that my principal amusement on Sundays was making mechanical drawings.

I concur fully with the idea expressed in the "American Machinist," that previous shop experience should offset some of the more advanced of the present requirements for admission to engineering schools. In fact, I would go further, and say that I think shop experience and a good grammar-school education should be the only requirements for admission to such a school, and that practical knowledge and duties should be taught in preference to theories and useless problems,

such as the "mathematical study of shades, shadows and perspective," which should be entirely done away with. Life is too short and time too precious to waste them on any line of thought or study that is not to be called upon for everyday use in the life work of the person in question.

I was greatly impressed the other day, in a tour through the engineering and physical laboratories of the Lawrence Scientific School at Harvard University, with the Boston Society of Civil Engineers, by the methods of study there. Instead of the student spending hours of poring over books, subjects were brought to his mind by lectures, illustrated by lantern slides and models in such a manner as to convey ideas to his mind in short, terse, crisp doses, proven beyond all question, and so more readily assimilated and remembered. A case in point: We were shown into the Geographical Lecture Room; two papier-maché models of a river valley were shown to us—one of the original valley, silted up with alluvial drift; the second showing how the gradually narrowing stream had terraced its way through this drift and, meandering backward and forward, run up against a spur of the original valley rock on one side and formed a waterfall, which we engineers had then proceeded to develop into a water power, with mills, factories, city, etc. The talk was short—occupying less than five minutes—yet I heard many members say they had learned more in that five minutes of the formation of waterfalls than they ever knew before. It is the professors who must do the studying nowadays, and the tabulating into formulæ and tables of practical results, and give it to succeeding generations in short meter—small doses and often. Where can we find the ideal engineering school on these lines, turning out good foremen, superintendents and chief engineers, as well as professional men?

WM. O. WEBBER.

Boston, Mass.

[We have no hesitation is saying that the establishment in which Mr. Webber carried out his admirable system of apprenticeship secured a return commensurate with his enlightened policy. It is a common remark that the only way to get good men is to raise them, and there is no question that a shop having such a spirit in its management will secure a spirit of hearty co-operation among its men, which will accomplish more than any would-be cattle driver on earth. "There is a great deal of human nature about man."—Ed.]

Logarithms—Foote's Constant.

Editor American Machinist:

I have just read Mr. Foote's article advocating the use of logarithms, and can indorse all he says of them. I do not think, though, that Mr. Foote has ever seen a copy of "Bowditch's Navigator," or he would not have such a bad opinion of text-books in general, for this excellent work devotes just eight pages to the practical application of logarithms, including multiplication, division, powers, roots, rule of three, interest, and also logarithmic sines, tangents, etc., and not a ghost of a theory. This is rather a bulky work, as there is necessarily a lot of matter that is useless to the ordinary machinist, and I regret that the logarithmic part is not published by itself. I, too, had to learn the theory of logarithms when at school, even to the extent of constructing a very small part of a table, but have not found that knowledge of as much benefit as what I gathered from the book prepared for the use of the "jolly tar."

I have seen Foote's constant in a number of tables of constants; the only one I can lay my hands on now being "Loomis' Practical Astromony," where it is given to ten decimal places.

Brooklyn. WALTER GRIBBEN.

Editor American Machinist:

The use of the constant 0.31831, the ratio of the diameter to the circumference of a circle, is not at all new, as your christening it "Foote's Constant" would indicate. I was taught it in a grammar school in Philadelphia more than thirty years ago. It will also be found in print on page 57 of my "Mechanical Engineer's Pocket Book," in the following form:

"Ratio of diameter to circumference = reciprocal of π = 0.3183099. Also as follows: If D = diameter, C = circumference; $D = \frac{C}{\pi} = 0.31831\ C$."

Referring to M. E.'s letter on "Strength of Gear Teeth," I would refer him to what I have written on that subject, on pages 900 to 905 of the "Pocket Book."

New York. WM. KENT.

Editor American Machinist:

Regarding "Foote's Constant for Diameters," would say that this has been suggested in print, and may be found on page 5 of Oscar J. Beale's "Practical Treatise on Gearing," published by Brown & Sharpe Mfg. Co., 1887.

It does not seem possible that this should have been the first publication of it—though it is the only one that I remember to have seen—as it would seem that the first thought of an engineer—or a lazy one, anyhow, like me (perhaps some of your readers will not admit that I am an engineer, but they will admit that I am lazy)—would be to use the reciprocal of a number for multiplying, rather than go through a long problem of division, which involves multiplication, anyhow. 0.31831 is simply the reciprocal of 3.14159.

I have an idea that Mr. Durfee could prove than Noah used this thing when he was "figgering" how long it would take that dove to get back.

Meriden, Conn. W. L. CHENEY.

[We have several additional letters of the same import, and it is clear that we shall have to take a back track on the suggestion that Mr. Foote was first to suggest in print the use of the reciprocal of π One correspondent has found it in a book published in 1825. We doubt not, however, that its use will be new to many of our readers.—Ed.]

Curvature of the Earth — Dividing Circles—Working Drawings—Oil on Taps and Reamers.

Editor American Machinist:

Just a few words more on the curvature of the earth. I think by using some of "Easy Way's" eye salve and an eye glass, perhaps Tecumseh Swift will be able to see about how much he has been out of plumb. As for myself, I am perfectly willing to be jostled about a good deal, provided that good may come of it.

It is dangerous, of course, to get into deep water when one cannot swim; but when learning this art I found it a great help to venture out a little, and ever since I have been venturing along the danger line, and when not sure that my ground was tenable, have relied largely on that process of reasoning which lies midway between perfect certainty and guesswork —"reliable approximation," as you so aptly style it in an editorial of February 13th.

It was from such a standpoint that I ventured to question the correctness of the formula for determining the curvature of the earth, as given by Tecumseh Swift, in December 5th issue. However much I may have gone "askew" in my criticism of January 30th, it is gratifying to know that such contributors as "Superannuated" and "Observer" have clearly demonstrated the fact that the curvature of the earth is not as the square of the distance—although this rule may give a reliable approximation for short distances. I do not know the above gentlemen, but will improve this opportunity of extending to them my sincere thanks for the service they have rendered; not in the narrow sense of vindicating my statement, but in furnishing hints along lines which may attract the attention of hundreds of readers of the "American Machinist," and lead them to fuller investigations of those very interesting lines of study found in the higher mathematics. Just here I feel like recognizing the good offices, too, of your contributor, "Easy Way" (who is also a stranger to me), in his efforts put forth in your January 30th number to vindicate my statements concerning dividing or multiplying calipers.

There are one or two points which I may call attention to, which have not been brought out by the discussions on the best method of dividing a circle, as presented by William Newton, February 6th, and Walter Gribben, February 20th.

I do not think there is anything to commend in the use of a number of triangles for dividing the circle, or for securing any number of degrees. Why not use either a metal or a transparent quadrant for this purpose? Then, when it comes to dividing a circle into any great number of divisions, I have found it the most accurate and expeditious way to first get an equal division in some multiple of the whole number of parts; as, for example, if 50 be the number, first divide the circle into 10 parts, and then the subdivision of each of these into 5 parts will be comparatively an easy matter.

While on this subject, permit me to go a little further, to say that I think a great deal of time and labor is often wasted on working drawings. The draftsman seems to lose sight of the fact that measures are to be taken from figures, and not by applying a rule or scale; at least this, I believe, is the common practice. Of course, such a workman should have some pride in having his work appear neat and artistic; but the point I make is, that entirely too much time may be consumed in securing unnecessary accuracy as to small and unimportant details. It must be admitted, however, that in the drawing room, as in the machine shop, the speedy and profitable man must be possessed of nice judgment, to know when to be exact, and when not to be.

I have been interested in the question now being discussed as to when oil should be used on taps, reamers and other work, and when a substitute may be employed. My experience has invariably been, that where severe usage is required of tools, as in the case of tapping wrought iron and cutting bolt threads, nothing equals good lard oil. A few times I have been induced to try substitutes, but the experiment in every case has proved very expensive, many times the saving in oil having been expended on dies.

It has always been my practice to use oil when tapping cast iron, and I cannot say whether or not it has a preserving tendency; but it is noticeable that, when oil is not used, the tap will, so to speak, cut larger than itself—that is to say, a screw which fits an oil-tapped hole properly will fit loosely in one tapped dry.

In ordinary lathe or planer work, especially where a smooth finish is desirable, it is well known that soda water, or soap suds, answers a good purpose; but it is not so generally known, I think, that the efficiency of the mixture will be greatly improved by proper mixing. The following quantities are sufficient for a barrel of water, and they are well worth a trial:

5 pounds common soap;
5 pounds sal-soda;
¼ pound carbonate ammonia;
¼ pound salts tartar;
¼ pound borax.

These ingredients should be thoroughly dissolved by boiling. They will not rust the tools or work, and will remain good even in the warmest weather.

QUIRK.

[As it seems to be pretty well established by this time, thanks to Tecumseh Swift, that the circumference of the earth is approximately a true circle, and as that shape is good for rolling purposes, it will be best to let her roll on in peace and free from our contributory friction, giving our attention for the present to the leveling of our heads and our machinery according to the most approved methods of "reliable approximation."—Ed.]

Foote's Constant — Short Rule for Areas.

Editor American Machinist:

Mr. Foote, in his article on Logarithms, gives us a constant for finding the diameter of circle from the circumference, and states that he has never seen it in print. He must have made a very limited search for it, as I have been familiar with this formula for fourteen or fifteen years, having first noticed it in Molesworth's "Pocket Book of Engineering Formulæ". It is also to be found in "Nystrom" and in Morrison's "Practical Engineer".

In looking over my notebook in search of this formula, I ran across something of the same kind for finding the area of a circle. I am unable to state from what source I got this rule, but can vouch for the simplicity and handiness of it. Perhaps it will be as familiar to Mr. Foote as his formula is to me. However, I will give the rule, and perhaps some of your readers will know the author of it, and proper credit can be given to him:

I square the diameter and multiply by .7, repeat the product one decimal point to the right, multiply result by .2, and repeat as before. Take, as example, 36 inches diameter:

$36 \times 36 =$	1296
multiply by .7	9072
repeat	9072
multiply by .2	18144
repeat	18144
giving	1017.8784 = req. area.

The ease and usefulness of this rule will, I think, be apparent to anyone, as, after the first row of figures are obtained, the rest may be done mentally and very quickly, with little chance of error.

I wish that any of your readers who have any short cuts like these would make them known, as they are of great benefit to all who have any calculating to make.

RICHARD THIRSK.

[Mr. Thirsk's multipliers are equivalent to .7854, as will be seen at once:

first multiplier		.7
second "		.07
third "	$.07 \times .2$	.014
fourth "		.0014
sum		.7854

—Ed.]

Foote's Constant.

Editor American Machinist:

I do not see anything very new in your correspondent, Mr. Foote's rule for finding the diameter of a circle from the circumference. He simply uses the reciprocal of *Pi*. I have used reciprocals often in mathematical work, especially in the slide rule, where almost all the formulae use reciprocals. They are very handy and often save many figures.

C. H. MARION.

The great number of communications which we have received, calling attention to books in which the multiplier to which Mr. Foote called attention may be found (of which letters we have published but a small part), will explain to many of our correspondents why their communications do not appear in our columns. We may be pardoned for saying that this flood of letters on a subject of this kind is to us a very gratifying evidence of the care with which the "American Machinist" is read. Keep watch on us, friends; we are all human.

The bicycle seems to be responsible for a great many attempts of novices to write for the daily papers on mechanical subjects which they know nothing of, and which attempts only tend to confuse those who innocently read them, and to add to the gaiety of nations. One of these writers recently undertook to show how much superior the bicycle is to a freight car as a carrying vehicle, and he refers to the "factor of strength," and says that in a freight car the "factor of strength" is very large, being nearly one-half the weight the car will safely carry; while in the bicycle the "factor of strength" is very small, wheels of 22 to 23 pounds being guaranteed to carry from 300 to 400 pounds; which is altogether a beautiful example of mixing things.

Rust, as we all know, is one of the most persistent enemies of the machine constructor and manufacturer whose goods are oxidizable, and a satisfactory rust preventive is therefore of special importance. Such a preventive seems to have been found in the new material called "Mannocitin," which seems to possess the valuable qualities of absolutely preventing rust, perfect transparency, durability under handling, and the ability to resist absorption by paper wrappers that may be around the goods. The Cleveland Twist Drill Co., Cleveland, O., for instance, have found considerable difficulty, resulting from the absorption of rust, preserving material by paper wrappers put around packages of drills. With "Mannocitin" they state that there is no such absorption, and no difficulty whatever.

AMERICAN MACHINIST

PUBLISHED EVERY THURSDAY

BY THE

AMERICAN MACHINIST PUBLISHING CO.,

256 BROADWAY, NEW YORK.

ANGUS SINCLAIR, Pres't. JOHN A. HILL, Treas.
C. A. HANSMANN, Sec'y.

C. P. DAY, Manager Adv. Dept.

FRED J. MILLER, Editor.
FRANK RICHARDS, F. A. HALSEY, EDWARD P. BUFFET, } Associate Editors.

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☞ *Every correspondent, in order to secure attention, must give his full name and address; not necessarily for publication, but as a guarantee of good faith.*

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THE INTERNATIONAL NEWS COMPANY, BREAM'S BLDGS., Chancery Lane, LONDON, E. C., ENG., will receive subscriptions for the AMERICAN MACHINIST at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.

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The Legitimate Field of the Electric Motor.

There can be no doubt that a large factor in the success of the electric motor has been its mechanical simplicity, combined with the fact that the motion at its origin is circular. Most machines receive a circular motion, although, perhaps, changing it many times in fulfilling their functions; and the result is that the connection between motor and machine is of the simplest possible character. A feature which sometimes operates against the motor is its high speed, which involves, in many cases, a train of reducing gearing which it is desirable to get rid of. This, while objectionable, may not be of sufficient moment to weigh seriously against the advantages named, especially as, with reducing gearing included, the electric is for most purposes simpler than any other known motor.

It seems to be a universal law of human activity that the impulse acquired by a device in its legitimate field shall carry it to applications without that field, and where, instead of being appropriate, it becomes inappropriate.

An illustration of these remarks may be found in the application of a motor to a small chain hoist. We have become so accustomed to winding a hoisting chain upon a drum, and so converting a rotary to a straight line motion, as to almost forget that the motion of hoisting is a straight-line motion, and that the most appropriate motion for such work is one giving a straight-line motion at its origin. Such a motor is found in the straight-lift air hoist, which connects the motor to the load in the simplest conceivable manner, and so offers the same advantage for this purpose that the electric motor offers for driving most ordinary machinery. The disadvantage of high speed in the electric motor is here at its maximum, as the speeds of hoisting are necessarily slow, and the train of reducing gearing is correspondingly long. The air hoist meets this condition also, as the speed of the piston is naturally the same as that of the load.

Another application in which the electric motor seems to be contra-indicated, as the doctors would say, is to pumping. Here again we have the conditions of straight-line motion and slow speed at the point where the work is done, with a corresponding length and complexity of connecting gearing if the electric motor is to be used. Compressed air applies here even more directly and simply than to hoisting machinery, the pumping being done in pneumatic pumps now on the market, by air pressure applied directly to the surface of the water in a closed chamber, without the intervention of connecting machinery of any kind. The resulting machine is of the simplest conceivable kind, and reduces the problem to its lowest terms.

We do not mean to imply that the geared electric pumps are not good and, in many cases, desirable machines. Special cases require special treatment, and with electricity already laid on, or with special difficulties in the way of using the compressed-air appliances, it would be better judgment in many cases to apply the electric hoist or pump rather than install a complete air plant for a minor purpose. Again, in traveling cranes the length of bridge and trolley travel render direct-pulling cylinders for those purposes inapplicable, and so make rotary motors of some sort necessary; and the facility with which electric power may be picked up anywhere, by simple contact with a wire, tells powerfully in its favor.

The fact remains, however, that judged on its fundamental fitness for the purpose, and apart from the conditions which in some cases determine against it, compressed air would seem to furnish a better and more general solution of the problems of pumping and simple shop hoisting than electricity.

The Dangers of Belting.

Probably few persons, whether mechanics or not, realize how many accidents occur in connection with belting, and how many of these accidents are fatal. With a full appreciation of the dangers of steam boilers, circular saws, cheap elevators, and similar terrors of the mechanical world, the belt seems to be able to hold its own with any of them as an agent of destruction. As belts are in use wherever machinery turns, so the accidents caused by them are distributed over the whole land, and no complete record of them is ever compiled, no comprehensive view of their malignant work is ever obtained by any individual; but, wherever one may live, he will find the local press occasionally telling of one of these casualties, usually with horrifying details of whirling limbs and scattered brains.

These belting accidents are, as a rule, usually the result of carelessness or of ignorance, the latter case too often meaning the carelessness of another who has permitted the ignorant exposure. After nearly every accident it might be truthfully remarked that it need not have occurred, and that it would not have occurred if everything had been all right and if someone had not done wrong. Belting accidents do not occur where belts are running steadily and where they are left alone. They never chase their victims, but they do sometimes suggest the existence of some power of fascination to draw the innocent toward them. When a belt breaks while running, it usually simply drops down in a heap on the floor, although occasionally it winds around the running shaft and catches a victim in its coils as it goes.

When a belt is being thrown on to a

pulley on a running shaft, when it is being thrown off a running pulley, when it is dangling from a running shaft in the process of relacing or repairing—these are all times of danger. The responsibility for the events that occur is to be divided between the belt itself, burs and rough spots upon the shaft, projecting set-screw heads, notches in the edge of pulleys, slipping ladders, loose clothing of workmen, and other particulars all more or less wrong in themselves.

It is idle to think that the handling of belts in connection with running shafting can ever be stopped, any more than the starting of kitchen fires with kerosene can be stopped; but much may be done to make the practice less frequent, and to make it, when necessary, as safe as possible. It is very remarkable that, with the great quantity of belting employed in every industrial establishment, it is so rare to find any man whose business it is to look after the belts and see that they are always in order, and if repairs, taking up or other adjustment is necessary, to do it at times when the shafting is stopped. If belts are large enough to do their work without overstraining, the giving out of them and the handling of them during running hours would seem to demand an explanation.

It seems as though every obstacle in the way of the new bridge over the East River at New York has been removed, and that the work of construction will now go forward. The bridge is expected to cost about $10,000,000, and will be the greatest structure of the kind in the world. The engineer who will direct the work is Leffert L. Buck.

Questions and Answers.

Name and address of writer must accompany every question.

Questions must pertain to our specialties and must be of general interest.

We cannot undertake to answer questions by mail.

An annoying typographical error occurred in our reply to Question (47). The last logarithm given has 6. for a characteristic, while it should have $\bar{4}$., both by multiplication and to agree with the previous determination. The final answer to the problem, as taken from the table of logarithms, should have been 1893.6, not 1793.5, as given.

(52) E. H. L., Brooklyn, N. Y., asks: What degree of temperature is iron when it has a dark-red color? The question was asked at an engineer's examination. I have asked a great many in the iron-heating business, and could not find out. A.—Much depends on the eyes of the observer as to when he will begin to see red heat. It is usually said, however, that iron begins to be visibly red in the dark at about 700 degrees Fahr. The following is the table constructed by Mr. Pouillet, and which is generally accepted:

	Deg. F.
Incipient red heat	977
Dull red heat	1,292
Incipient cherry red	1,472
Cherry red	1,652
Clear cherry red	1,832
Deep orange	2,021
Clear orange	2,192
White heat	2,372
Bright white	2,552
Dazzling white	2,732 to 2,912

In connection with this, the following table of temper colors and temperatures is interesting. A bar of bright iron or steel, slowly heated in contact with air, assumes the following tints at the temperatures given.

	Deg. F.
Yellow	437
Orange	473
Red	509
Violet	531
Indigo	550
Blue	559
Green	630
Oxide gray	752

(53) W. S. C., Los Angeles, Cal., asks: 1. What should be the size and power of an air compressor to fill a reservoir 16 inches in diameter and 2 feet long, pressure in reservoir to be 50 pounds at the end of a half hour? A.—The capacity of the tank is $16^2 \times .7854 \times 24 = 4{,}825.5$ cubic inches $= 2.79$ cubic feet. A pressure of 50 pounds is equal to say, $4\frac{1}{3}$ atmospheres; $(50 + 15) \div 15 = 4\frac{1}{3}$; and as the reservoir at the beginning will contain air at a pressure of one atmosphere, there will remain only $3\frac{1}{3}$ atmospheres to be pumped in. Then $2.79 \times 3\frac{1}{3} = 9.3$ cubic feet of free air to be pumped in thirty minutes. This would be at the rate of .31 cubic foot, or 535.68 cubic inches, per minute. If the pump made 100 strokes per minute, the required free-air capacity would then be 5.36 cubic inches per stroke; and assuming the pump to be single-acting, this, with a liberal addition for contingencies, should be the piston displacement. A plunger pump $1\frac{1}{4}$ inches in diameter and 6 inches stroke would give $1.25^2 \times .7854 \times 6 = 7.32$ cubic inches, and this should be sufficient. The power required for the pump would be very light at first, and would increase with the pressure in the reservoir. The final rate of power required would be $1.25^2 \times .7854 \times 27 \times \frac{1}{2} \times 100 \div 33{,}000 = .048$ horse-power. A pump could be made that would enable a man to fill the above reservoir in ten minutes or less, but we have answered the question as it was asked. 2. Suppose we have a tank 4 feet in diameter and 9 feet long, and wish to fill it with molasses. How much quicker will it fill with a good vacuum in the tank than by gravity alone? The diameter of the supply pipe is 3 inches and the head is 8 feet. What should be the size and power of an air pump to form a good vacuum in twenty minutes? A.—A head of 8 feet would give a pressure of about $3\frac{1}{2}$ pounds, and whatever vacuum in pounds per square inch was produced in the tank would be to that extent an addition to the head or pressure to which the liquid was subjected. The increase in rate of flow should be nearly as the square roots of the respective pressures. If a vacuum of $10\frac{1}{2}$ pounds were produced in the tank, the total pressure would be increased fourfold, and the flow should be nearly doubled. The best way to produce a vacuum would be to fill the tank with steam to a little appreciable pressure, and then to cool the tank, or allow it to cool, and condense the steam. Most of the water of condensation might be collected in a small chamber below the bottom of the tank, with a valve to shut it off before admitting the molasses. To produce a vacuum by means of an air pump would require considerable power. The capacity of the tank is $4^2 \times .7854 \times 9 = 113$ cubic feet. If we had an air pump with cylinder 1 foot diameter by 1 foot stroke, then its capacity per single stroke would be .7854 cubic foot, and the ratio of the cylinder capacity to that of the tank would be $\frac{.7854}{113} = .00695$; and if the piston of this pump made 100 strokes per minute for twenty minutes, or 2,000 strokes, the absolute pressure would probably be brought down as low as 4 pounds, so that there would be an excess of atmospheric pressure of $10\frac{1}{2}$ pounds, as assumed above, or a little more. The final power required to work the pump would be about 5 horse-power.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Adding Machine. Grant; see page 36.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Engine castings ¼ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Aluminum and Brass Castings, Machinery, Name Plates. Twining Campbell, Paterson, N. J.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Mannocitin permanently prevents rust. Testimonials explain. O. Goetze, 14 Whitehall st., N. Y.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Just issued—Catalog No. 8. Mailed Free. Clayton Air Compressor Works, 28 Cortlandt st., New York.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Key Seaters for any length of hub or width of keyway. New, handy machines. Mitts & Merrill. 913 Tilden street, Saginaw, Mich.

Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, Tolland, Conn.

Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

Literary Notes.

MACHINE SHOP ARITHMETIC. By Fred. H. Colvin and Walter Lee Cheney, Editors of "Machinery." Published by the Practical Publishing Co., East Orange, N. J. Size, 3¼ x 5¼ inches; flexible cover. Price 50 cents.

This useful little manual relates especially to the ordinary daily calculations of the shop. Some of the chapters are on Screw-Cutting, Drilling for Taps, Speed of Pulleys and Gears, Speed of Drills and Taps, Speed of Grindstones and Emery Wheels. Decimals, Square and Cube Roots, Formulas, Mensuration and Abbreviated Calculations are also discussed. To all who do not understand the subjects discussed, the book will be found very useful; while to many who do understand them, but who do not often have to make the calculations, the book will serve as a useful reminder.

ELECTRICITY UP TO DATE FOR LIGHT, POWER AND TRACTION. By John B. Verity. Frederick Warne & Co. 5 x 7½ inches; 238 pages; illustrated. Fifth edition. Price $1.00.

This is a popular account of the various applications of electricity to lighting, power, heating, traction and medicine. It does not enter into detailed descriptions of apparatus, nor the principles of electricity.

SYNOPSIS OF CURRENT ELECTRICAL LITERATURE. 1895. By Max Osterberg, E.E., A.M., Fellow of Columbia College. D. Van Nostrand Co. 7 x 10 inches, 143 pages. Price, $1.00.

This is a new addition to the various indexes to periodical engineering literature which the immense volume of such literature has called into existence. The book is, however, more than an index, a synopsis of each publication noticed being given, whereby the scope and conclusions of the article are indicated. The articles indexed are from American, English, French and German sources. Within its field the book will be found of great value.

Recent Inventions in Metal-Working Machines.

Figs. 1, 2, 3 and 4 show, respectively, a plan, end elevation, detail of spacing mechanism and vertical section of the

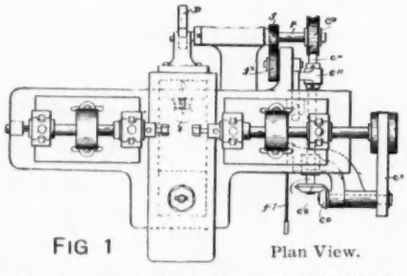

FIG 1 Plan View.

AUTOMATIC VALVE MILLING MACHINE.

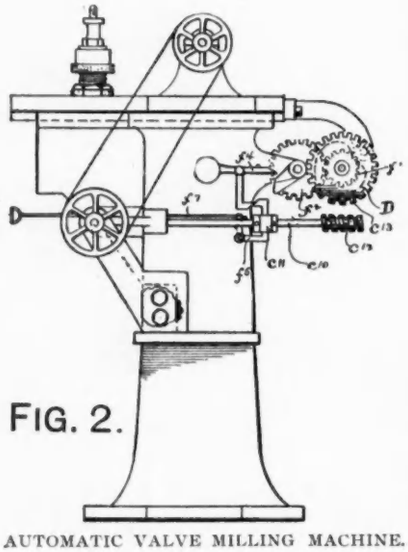

FIG. 2.

AUTOMATIC VALVE MILLING MACHINE.

same, in an automatic valve milling machine, the invention of Messrs. J. G. Oliver and G. C. Bardons, of Cleveland, O.

The object of the invention is to provide automatic mechanism for revolving the work, and an automatic stop at the completion of each piece.

The arrangement and adjustment of the

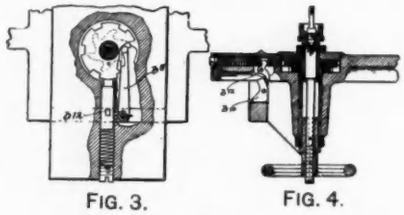

FIG. 3. FIG. 4.

AUTOMATIC VALVE MILLING MACHINE.

cutters are as usual in this class of machines. For operating the spacing and stop mechanism, the right-hand spindle

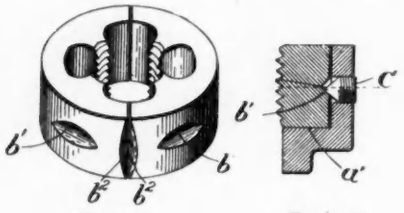

FIG 6 FIG 7

NEW SCREW CUTTING DIE.

is extended, and through c^5, c^8, c^9, c^{10}, c^{13}, F and cam D the work-table is reciprocated, a weight E opposing cam D.

As best seen in Fig. 2, c^{11} is a loose bearing supported in its raised position on the weighted bell-crank lever f^4, and when dropped to disengage worm c^{12}, it is held by a second bell-crank f^5. Lever f^4 is unlatched by cam f^3. The ratio of gears f^1 and f^2, for milling hexagonal valves being 1 to 3, the worm is dropped at the completion of the third cut. A hand lever f^7 raises and relocks c^{11} in position to start the work-feeding and rotating mechanism. Of course, the gear ratio and spacing mechanism may be readily arranged to face work of any number of sides.

In Fig. 3, pawl b^8, fast on the main frame, effects the spacing in a manner readily understood. The trips b^{12}, b^{13} (Fig. 4) unlock the turret as it moves to the left, and pass each other idly on the return. This figure also clearly illustrates the work-clamping device.

Figs. 6 and 7 show an improvement in dies, the invention of Mr. A. J. Smart, of Greenfield, Mass. The object accomplished is the easy adjustment and secure holding of the die, either side up, in the holding ring. The pointed adjusting screws enter the milled slots b^2 in the usual manner. The backing and holding-down screws C, being set in the ring slightly below the slots b^1 in the middle of the die, answer the double purpose of adjustment and of securely holding the die against the shoulder a^1.

Information Wanted.

We want information from all parts of the country regarding new industrial establishments, or enlargements and improvement of old ones.

We will pay for such information, and would like the names and addresses of those who will furnish it. If you will do it, send us your name and address.

Rope-Driving Practice.

BY W. H. BOOTH.

It is perfectly true, as "M. E." writes, that there is no distrust of rope gearing in England. The reason is simply that it has been carefully studied, and there is an enormous field of experience in the question, so that bad details have been eliminated. Ropes very quickly displaced belts; but in the early days of rope-driving, belting was not made of the excellence that is now the case. There was not the stretching of the separate hides which is, I believe, now the practice of best makers. But in one respect, English practice in rope-driving is in advance of other practice, and that is in the use of cotton ropes. A cotton rope is not to be named on the same day as a rope of hemp. The fiber of hemp—especially of manila—is a rough and coarsely uneven fiber, and a manila rope cannot be made solid. It may be made harsh and unyielding, but it is impossible to make a rope of hemp to compare with one of cotton. In a cotton rope there are sixty or eighty thousand separate threads, usually of No. 32 yarn. By No. 32 is meant that a single thread of the yarn will require a length of 32 hanks to weigh a pound, a hank being 840 yards. In other words, the ropes of a 1,000 horse-power engine will consume from seventy to one hundred thousand miles of single yarn.

The separate yarns are divided between the three strands of which the rope is built up, three being the recognized best number of strands; and in each strand of the best-made rope there is a division of the strand into many smaller strands, so arranged that if a length of rope strand be taken of, say, three inches it can be peeled off in successive layers; and in this way, when a rope wears, it is only one set of threads. Every thread in the rope maintains its proper distance from the surface, so that there is no general destruction of a rope by wear.

With such exactly-built ropes there is practically an absolute uniformity of size and hardness, and this is different from what obtains with manila. Consequently, every rope in a set of cotton ropes sinks equally deep in its groove.

The raw material of the ropes is almost invariably American or Egyptian cotton. Egyptian has rather taken the lead, but it is said there is practically no difference between the two.

The diameter of the smallest pulley is usually taken as thirty diameters of rope as a minimum; but it must be remembered that if a rope has to run over a guide pulley, and to take a reverse curvature in doing so, it will suffer far more than in bending in one direction only. From some recent evidence brought to my notice, it would appear that as much or more harm would be done to a rope if led in an **S**-curve around a pair of 4-foot pulleys, as if led round one 2-foot pulley, so destructive is the effect of back and forward bending as compared with bending in one direction only. The effect is to reduce the middle of the rope to dust, the outside remaining apparently sound.

It is a great mistake to apply much composition to ropes. Only enough should be put on to prevent the surface of the rope from fluffing up. A composition sometimes used is plumbago and molasses; but this is not to give adhesion. Ropes do not slip, for they gain grip by reason of the wedge action of the grooves in which they work. The angle between the sides of the grooves is variously 40 to 45 degrees, and the bottom of the groove is usually semi-circular in English practice, with a 3/8-inch radius. Certain continental practice favors deeper grooves with flat bottoms; but so long as the ropes do not touch the bottom of the grooves, this is a point of no importance. It is important that the grooves of the driver and driven pulley should be exactly opposite. Possibly, it is lack of this that often causes ropes to revolve round their own axes, in place of bedding to shape in the groove. A revolving rope is thus squeezed continuously on different sides, and cannot become consolidated. It is exposed to constant internal friction, and will be less durable than a bedded rope, which, under fair conditions, may last a dozen years, or even more.

When the continuous rope is employed, not only is it subject to numerous double bends, but it never enters or leaves a groove properly, for the grooves are never opposite to each other, but simply are a half groove removed laterally; while the final pass of the rope has to be taken from the extreme left of one pulley to the extreme right of the other pulley, to bring the rope back again to No. 1 groove after its circuit of reduplication.

Another advantage of the system of independent ropes is that, in event of failure of one rope, it first shows signs of weakness, and stretches somewhat so as to take a less share of the load. It can be removed, the remainder of the ropes being fully able to run without it, and a fresh rope can be put on at leisure. This is not the case with one long, reduplicated single rope, which is no joke to replace if broken and unwound, and is far more liable to cause an accident if it should break, as well as being far more liable to break, for it cannot refuse, by stretching, to perform its full duty at every part of its length.

In the early days of rope-driving their diameter was 2 inches, but at the present time they are only 1½ and 1⅝ inches. Thinner ropes, of course, work better than thick, for they suffer less by bending. Thick ropes have the advantage of enabling narrower pulleys to be employed, and this may be an advantage when it is desired to keep the span of a shaft small between the bearings. The various proportions of rope diameter, speed and pulley diameter are all a matter of compromise, like so much in mechanical engineering.

The necessity of using cotton ropes, or ropes of a uniform texture, is important, in view of the fact that ropes of different diameters will sink to different depths in the grooves; and if this occurs, it is obvious that one rope must perform a greater share of work than another, and this must cause greater friction, for one or both of the ropes must either slip or stretch.

With well-designed rope gears, it is not likely that there is an excess of power wasted beyond what is wasted by belts, but rope-driving has been accompanied by large and heavy fly-rims, and it is the friction of the engine shaft carrying these heavy wheels that has, perhaps, led up to the idea.

Finally, in regard to velocity, there is no necessity to run ropes at high speed, for they are at their maximum power at about 80 feet velocity per second, and even at 60 feet per second they are not far behind. It is the rapid increase of the stress due to centrifugal force that makes a rope so nearly as efficient at 60 feet as at 80 feet. Beyond 80 feet, the centrifugal tension increases faster than the power capacity, and considerable endeavor should be made to keep speeds below 100 feet velocity. Speeds of 7,000 feet per minute are not unknown, but they are to be avoided, if possible, for they are only economically possible when high unit stress is allowed in the ropes; otherwise the proportion of centrifugal stress is too great as compared with the net working stress, and a high rope stress cannot be accompanied by longevity. In temporary installations, the stress in a rope may be very much increased beyond what is proper for a factory expected to run a dozen years on one set of ropes. Each rope in a set may be very well allowed to turn 40 to 50 horse-power for durable and permanent work, and considerably more for temporary work.

Good Performance of Single-Cylinder Condensing Engines.

Our esteemed correspondent, Mr. Arthur Bollinckx, of Brussels, Belgium, forwards to us the following official report of tests made with two similar engines designed by him, and employed in an important electric lighting station. The results, it will be seen, are for the type of engine remarkable. The engines were each single-cylinder, condensing, 17.7 inches by 34.5 inches at 80 revolutions, consuming 15.54 pounds of steam per horse-power per hour, inclusive of condense water in jackets:

Association pour la Surveillance des Chaudières à Vapeur. Directeur M. R. Vinçotte à Bruxelles.

EXTRACT FROM THE REPORT ON THE TEST.

Both engines have given the same result and have consumed only 7 kilos. 05. (15.54 pounds) of steam per Indicated H. P. and per hour. They were, besides, in the same conditions, as indicated hereunder:

DATE, JANUARY 7TH.	Engine No. 92.	Engine No. 91.
Mean pressure at boiler	7 Atm. 1. (89.2 lbs.) 2 Atm. 2. (30.87 lbs.) 0 Atm. .945	7 Atm. 1. (89.2 lbs.) 2 Atm. .52. (137.74 lbs.) 0 Atm. .947
Mean effective pressure in cylinder	116.5	134.8
Vacuum measured on the indicator cards	104.1	117.7
Maximum of H. P. developed	8.35	9.95
Minimum of H. P. developed	6.95	7.75
Cut off corresponding to	7.85	9.15
Maximum I. H. P.	80.53	79.90
Minimum I. H. P.	9.02	9.45
Mean I. H. P.		Steam Consumption.
Mean speed		9 Kilos. .93 (21.89 lbs.)
I. H. P. to overcome friction, without belt on fly-wheel.		
Trial without condenser		

All these tests result in the following:

1st. That the engines have consumed on an average 879 (1.937 pounds) grammes of coal with 10 per cent. ashes and 5.65 per cent. of wet.

2d. That the effective work is to the indicated H. P. 92.85 per cent. That is to say, the mechanical efficiency is 92.85 per cent.

3d. That one single boiler is quite sufficient to supply all the steam for one engine working non-condensing and developing 130 I. H. P.

4th. That all the conditions of regulation have been fulfilled.

5th. That the consumption of the engine, non-condensing, has been 9 kilos. .93 (21.89 pounds) of steam only per I. H. P. per hour; that is, 40 per cent. more than condensing.

Signed: Le Sous Directeur,
DEJACE.

Seen and Approved:
R. VINÇOTTE.

N. B.—About coal consumption: The

boilers, which were not made by us, our exclusive specialty being steam engines, have vaporized only 7 kilos. .7 of water per kilo. of coal, owing to their tubular system. Should the same have been Cornwall or Galloway's the production of steam might have been 9 kilo. of water per kilo. of coal, and in these conditions coal consumption would have been reduced to 783 grammes (1.68 pounds) per I. H. P. per hour.

A Large Machine-Shop Fire.

The works of the Garvin Machine Company, on Laight street, New York City, were totally destroyed by fire in the early morning of the 6th inst. The buildings occupied by this firm were two of six stories each, the fire originating in another six-story building adjoining, the flames being communicated through a belt hole in the wall. The loss to the company is, at this writing, estimated at $175,000, while the insurance carried was considerably higher than this. The works of the company were entirely destroyed during the blizzard of 1888, and a $25,000 fire occurred in the works about a month ago, during the heaviest storm of the season. The concern was crowded with work, and more than 400 men are thrown out of employment.

We are informed by Mr. Garvin that arrangements are nearly completed for a larger plant, with every improvement and facility, and in an absolutely fireproof building. As the patterns of the company are distributed through a number of foundries, the most serious loss that could occur to such a firm as this is not in this instance a complete one.

It is proper for us to get what consolation we can from the fact that other navies than ours have their troubles. The British torpedo-boat destroyers, we are told, are, as a class, haunted by ill-luck. The "Daring," of this class, was lately run into by a Calais packet. A hole was knocked into her side, and the inrush of water was stopped by a collision mat, and she started to run to Portsmouth. On the run, the crosshead bolt of the starboard engine broke and the cylinder was also broken.

The Waterbury Machinery Company, Waterbury, Conn., have acquired exclusive control for this country of all the patents of Alfred S. and Thos. Bolton, of Staffordshire, England, on continuous wire-drawing machines. These machines have been built for some years in England, and some of them have been imported to this country. American users of them will henceforth be supplied by the Waterbury Machinery Company.

If our correspondent who writes from Hopewell will inform us what State he is located in, we will endeavor to attend to his inquiries.

COMMERCIAL REVIEW.

New York, Saturday Evening, March 7.

Steam Machinery and Appliances.

Since our last report, the engine and boiler trades have passed through a dull season, but with the advent of spring there is, on the part of some sellers, greater hope. There are grounds for belief that in this market trade is more quiet than generally throughout the country. It might be difficult to point to any one district and say that there things are distinctly better, but trade enough comes from somewhere to keep certain of the manufacturers fairly busy.

A few of the New York sellers of engines perceive an improving business. It is true, one large manufacturer whose engines previous to a month ago were in quite active demand, notices a falling off in February and the month, all told, was certainly a poor one, not much better, if any, than the corresponding time of last year. But there has apparently been, since the middle of February, a little improvement in inquiry and, in some quarters, of demand. Prices have been very close.

The boiler trade has also experienced the dulness of mid-winter, and while there has not been a universal improvement, enough people report an increase of business to indicate that its general trend is toward the better. While the prices of boilers are now weak, they may be sustained a little by a stronger tube market.

The Harrison Safety Boiler Works, manufacturers, also, of feed-water heaters, separators, etc., have been having an active trade, but in the New York market, while they have had success in selling heaters and separators, the boilers themselves have been dull. Another concern which makes a specialty of feed-water heaters finds its trade fair, and a heating and steam supply house reports that in feed-water heaters and steam traps reigns a comparative quiet, though some activity preceded the winter period and the outlook is not discouraging.

Steam pumps are in fair selling. One concern, which had experienced a very good business early in the winter, noticed a falling off in February. On the other hand, a company which has, in the past, talked conservatively, is of opinion that buyers are now more willing to pay for a valuable article. It has secured some good contracts for marine pumps. Another company reports a continuation of the good demand it has had for some time past. We learn from still another source that the spring trade for waterworks is now coming on, and that mining pumps for export are also a feature.

Steam fittings, such as elbows and gate valves, have been decidedly quiet during the past month. There are as yet few indications of spring trade. It may be too early to expect much, and beside, the unpleasant weather has tended to hold things back by delaying building operations. In gages, injectors, etc., the margins of profit are exceedingly small. One seller reports a greater volume of business than last year, but that he has had to turn away part of it because of the low prices.

The Weston Engine Co., of Painted Post, N. Y., write us that they have observed, during the month of February, an increasing demand for high speed engines for electrical purposes, especially for direct connected work. Numerous inquiries and some orders come from country villages which are planning to use electricity for lighting. They are receiving an increasing number of orders from their representatives in different parts of the United States, with requests that they hold themselves in readiness to supply prospective orders at the shortest notice. They see increased activity in the boiler trade, have sold a good many during February, and are now rushed to fill telegraphic orders for several boilers for the early spring trade. They say further: "We have been enlarging our works, especially our foundry department, having just begun upon a contract to supply 1,000 tons of castings for a large machinery company, and this in addition to our regular foundry work. Our force of employés has been increased 30 per cent. in number during the last month, and, all things considered, we look forward to the best year's business since 1892."

The foregoing favorable view of the situation is quite in contrast with the manifestations we have noticed of the New York City market. The Stirling Boiler Company, of Chicago, however, write, in much the same vein, that the record of their sales for the month of February is a very gratifying proof of the general improvement in trade conditions throughout the country, being greater than for any corresponding month in the history of the business.

The Enterprise Boiler Co., of Youngstown, O., in reply to interrogation as to the boiler trade, say: "We make more of a specialty of blast furnace work, large stacks, stand pipes, etc., than boilers. Comparing our business for the month just closed with February of last year, have found it almost impossible to secure the advance in plates and labor. The volume of inquiries has been about the same as a year ago, but have had more difficulty in closing contracts, although there was improvement during last week of the month. Considering the month alone, it was not as good as that of 1895, but the work in sight, that we have every reason to believe will shortly be closed, is considerably more than it was at that time, and the general feeling is much better."

The Watt-Campbell Co., of Newark, N. J., manufacturers of Corliss engines,

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our **subscription** list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

First-class draftsman and one capable of taking charge of machine works. J. C., AM. MACHINIST.

Sit. wanted, hyd. and spec. mch. designer; tech. educa.; can take charge room. Box 12, AM. MACH.

Competent dftsman wants pos. about April 1st; ten years' exp.; technical ref. Box 59, AM. MACH.

The M. E. and Supt. of a prominent engineering works desires to change. Address Box 54, care AMERICAN MACHINIST.

Any kind of drafting, designing and calculations done by experienced designer. Best of references. Address Box 57, AMERICAN MACHINIST.

Wanted—Man to travel and erect heavy steam engines. Address, stating age, experience and salary expected, to E. E., care MACHINIST.

Practical and successful designer; A1 draftsman; 20 yrs. varied exp. High grade eng. a specialty. Now open for eng. Address Box 263, Ridgway, Pa.

A practical machinist, 40 years of age, 12 years in charge of men, making piece work prices and estimates, wants position. B. E., care AM. MACH.

All round mach., 20 yrs.' exp, marine, stationary and pumping engines; jobbing; 6 yrs. in charge, wants sit. East. Address California, AM. MACH.

An up-to-date machine-shop foreman desires to make a change of place. Will come well recommended. Address Foreman, AMER. MACHINIST.

Wanted—Position by A 1 tool maker, 31 years old, 3 years experience as foreman. First-class reference. Address Drury, AMERICAN MACHINIST.

Wanted—Three first-class outside working bosses on tanks and stand pipes. State exp., last place of emp. and wages wanted. Add. V. D., AM. MACH.

Wanted—A first-class layer-out for general boiler work. State exp., last place of employment and wages wanted. Address V. D., care AM. MACHINIST.

Wanted—Traveling or local salesman to sell our goods on commission; side line or exclusively. Liberal terms. Howard Oil & Grease Co., Cleveland, O.

Mech. draftsman wants position; exp. in Corliss engs., complete steam plants, pumping mach. and gen. engineering. Good ref. Box 61, AM. MACH.

Resp. posit. wanted by pract. mech. and dr'ftsm'n Had consid. exp. in designing tools & mach., & held posit. as ch'f dftsm'n & ass't sup. A. B., AM. MACH.

Wanted—A capable machinist, one with natural ability and an adequate stock of ambition. If you have not these characteristics, please not apply. Address Box 38, Athol, Mass.

Wanted—Position as foreman machinist by a man of 18 years' experience on general machinery and repairs; 8 years as foreman. A1 references. Address Box 60, care AMERICAN MACHINIST.

A party with a number of years' exp. in manuf'g business desires a sit. Has had good success in management of help. Best of ref. given. Address Twenty-Three, P. O. Box 2003, Boston, Mass.

Wanted—Foreman for large malleable iron foundry, experienced in all departments and details, including mixing and molding. Address, stating qualifications and salary asked, X. X., AM. MACH.

Mechanical engineer and supt., experienced in engine, pump and boiler work, sugar, mill and elevator machy., wants position as supt. of machine shop or manufacturing concern. R. F., AM. MACH.

Mech. draftsman and designer wants position; 12 years experience on automatic engines, jigs, pumping and special mach. Comp'tent in charge of work. Eastern States pref. Box 51, AM. MACHINIST.

Wanted Dftsman—For the purpose of compiling & tabulating data in an eng. & boiler works. Accuracy on weights and dimensions; no designing. State experience and wages. V. D., care AM. MACH.

Wanted—A young, experienced and energetic man as foreman of a department making high grade interchangeable machinery. State age, wages expected and full particulars. Box 50, AM. MACH.

Machinery Manufacturer desiring reliable young man, technical grad. of some experience in capacity of draftsman, assistant to supt. or similar position, please address W., care of AMERICAN MACHINIST.

Situation wanted by a young man well up in the manufacture of hardware specialties; first-class tool and die maker; have experience in electrical and bicycle work; last five years as superintendent. P. D., AMERICAN MACHINIST.

Wanted—Position as foreman or supt. where a thorough knowledge of dies and presswork, with a wide exp. on gen. machinery and the proper management of labor, will bring in good returns to my employers and myself. Toledo, AMER. MACH.

The services of a thoro'ly comp. mechanical engineer may be secured by addressing undersigned, who possesses the qualifications of wide experience, education, executive qualities, and high ability as a designer. "Northcross," care AM. MACHINIST.

Wanted—By a young man of 24, well educated, with 6 yrs.' shop and drawing-room exp., and with some knowledge of steam engineer, a position with a consulting mechanical or electrical engineer. Vicinity of Phila. pref. L. A., care AMER. MACHINIST

MISCELLANEOUS WANTS.

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden st., Saginaw, Mich.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

6-inch, 8-inch and 10-inch screw cutting lathes, milling and gear cutting attachments. Wallace H. Mansfield, New Haven, Conn.

Successful Philadelphia manf. company (incorporated) desires to treat for eligible, permanent location; city or country. Box 58, AM. MACHINIST.

For Sale—Vols. 4 & 5, 6 & 7, 8 & 9, 10 & 11, bound in 4 vols. 12 bound single. Vols. 13, 14, 15, 16, 17, 18 unbound but complete. Price, $40.00. W. H. Ermentrout, Reading, Pa.

Wanted—A party with capital to take stock in a manufacturing enterprise which promises large div. Position in management to a large investor. For prospectus address D. M. C., AMER. MACHINIST.

For Sale—Well equipped factory for high-class metal work, located convenient to business district, Chicago. Will be sold at sacrifice, and building and grounds given as bonus. Address, "Owner," care Lord & Thomas, Chicago.

Man'f's.—Do you wish to build electric dynamos, motors, elevators, or any special electrical appar. at a minimum cost and strictly high grade, embodying the best feats. of mod. practice? I make a spec. of designs or work'g draw'gs for such appar. Write for infor. H. A. Balcome, 420 Lincoln av., Troy, O.

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"SHOP KINKS,"

By ROBERT GRIMSHAW. Showing special Ways of Doing Work Better, more Cheaply, or more Rapidly than Usual.

400 Pages, 225 Illustrations, $2.50.

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By JOHN T. USHER, Machinist,

320 Pages, 257 Illustrations, $2.50.

☞ *Illustrated circulars of both sent free.*

Our Catalogues of Books for Machinists, Engineers, Electricians, etc., also sent free.

NORMAN W. HENLEY & CO., Publishers,
15 Beekman Street, NEW YORK.

WIRE THE WATERBURY MACHINE CO., Waterbury, Conn., Owners U. S. Patents Bolton Continuous Drawing Machinery. Modern machines for drawing all kinds and sizes of wire by multiple dies.

say that during the past month their business has been about the same as it has for the past six months.

Iron and Other Metals.

The pig iron market has been distressingly quiet this week. The consumers seem inclined to pursue a hand-to-mouth waiting policy. They are earnestly hoping prices may go still lower, of which there is only too great a possibility. It is reported, nevertheless, that the Thomas Iron Co., an influential factor among northern irons, intends to raise prices. But this is merely a rumor which we publish for what it is worth.

As to the metals, copper is quieter, both at home and abroad, tin and lead are weaker, and the prices quoted in spelter for two or three weeks past are due by a combination of smelters.

Pittsburg Report for February.

February has passed without any great surprise, although its indications point to a healthy condition, especially in those lines of material which find entrance into machine shops and foundries. In a general way the tone of the market is strong, and this is certainly encouraging. Several large sales of foundry irons have been made during the latter part of the month, and reports are to the effect that more orders will be placed soon. The Pittsburg district is securing its full share of all the orders going.

Raw materials remain about as they were at our last monthly report, with perhaps some additional shading in a few lines. Bessemer steel has suffered in this way, while finished iron and steel and structural material seem to be holding their own. The general situation shows few changes of any note, but it is admitted that when changes have been made they have been in the direction of lower prices. The possibility of smaller figures keeps some consumers in the background.

The foundry trade is, in general, quiet. Only a few large orders for castings have been placed, and these were for mills in this district. The small foundries are suffering from the want of orders, and in one place near this city a number of molders have been laid off indefinitely. Prices for castings are still being quoted at the old figures.

In the machinery lines makers state that the demand has not materially improved, owing to delay of new building operations which have been for some time contemplated. The Frank-Kneeland Machine Company, one of the largest of its kind in this vicinity, has sufficient work on hand to keep the men steadily employed, but states that it could do more if it had the orders. The opinion is expressed that by April 1st things will take an upward turn, and that business will be much better.

C. A. Turner, one of our largest dealers

in mill supplies, etc., reports that the trade seems to be holding its own, there being a fair demand for all kinds of goods. Prices have undergone no change, and it looks as if they were in a settled state.

Engine and boiler sellers are in an unsatisfactory situation, and say that these goods were never before so quiet. Specifications are out for much new work, and bids have been submitted, but the work is being held back for some unaccountable reason. One contract of which the writer heard lately was received by the Pierpoint Boiler Company, calling for boilers of 1,500 horse-power capacity to be placed in the new steam plant of the Punxsutawney furnaces of Rogers, Brown & Co., of Cincinnati, O.

There seems to be quite an activity in drill presses, fans, blowers, etc., as dealers in this line have about all they can do to keep up with orders. Feed-water heaters, injectors, purifiers are also being taken up. The only bad feature in these lines is the exceedingly close figures being made. Competition is very keen, and those who succeed in obtaining contracts make very little profit.

Numerous electric-light plants are being installed in this district, there being probably a dozen or more concerns which contemplate changing their system of lighting. The Duquesne Theatre has asked for bids for a complete electric lighting plant to be installed within ninety days, and the boroughs of McKee's Rocks and Aspinwall are to put in plants to light those places. Many manufacturers are arranging to have portions of their works driven by electricity.

In spite of the present rather discouraging features of trade generally, there is a feeling that an improvement is coming, and that, with better financial conditions, the iron and steel trades will make a forward leap.

QUOTATIONS.

NEW YORK, Monday, March 9th.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$12 75 @ $13 25
No. 2 foundry, Northern	12 00 @ 12 50
No. 2 plain, Northern	11 25 @ 11 75
Gray Forge	11 25 @ 11 75
No. 1 foundry, Southern	12 50 @ 12 75
No. 2 foundry, Southern	11 50 @ 12 00
No. 3 foundry, Southern	11 25 @ 11 50
No. 1 soft, Southern	11 50 @ 12 00
No. 2 soft, Southern	11 25 @ 11 75
Foundry forge, Southern	11 00 @ 11 25

Bar Iron—Base, in Carloads—Mill price, on dock: common, 1.20 @ 1.30c.; refined, 1.30 @ 1.50c. Store prices, f. o. b.: common, 1.50 @ 1.60c.; refined, 1.60 @ 1.80c.

Tool Steel—Ordinary sizes, standard quality, 5¾ @ 7c.; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—About 1.55c. in carloads, mill price; from store, 1.85c. Special brands upward.

Cold Rolled Steel Shafting—Base, 2½c. in carloads; 2¾c. in smaller quantities; 2.85 @ 3c. from store.

Copper—Carload lots, Lake Superior ingot, 11⅛ @ 11¼c.; electrolytic, 10⅞ @ 11c.; casting copper, 10⅝ @ 10¾c.

Pig Tin—For round lots, 13.40c. f. o. b.

Pig Lead—In carloads, 3.15 @ 3.17½c.

Spelter—In carload lots, 4.15c., New York delivery.

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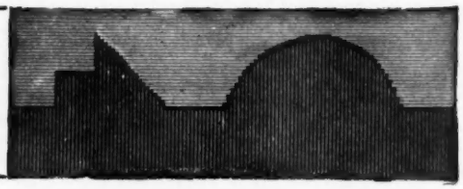

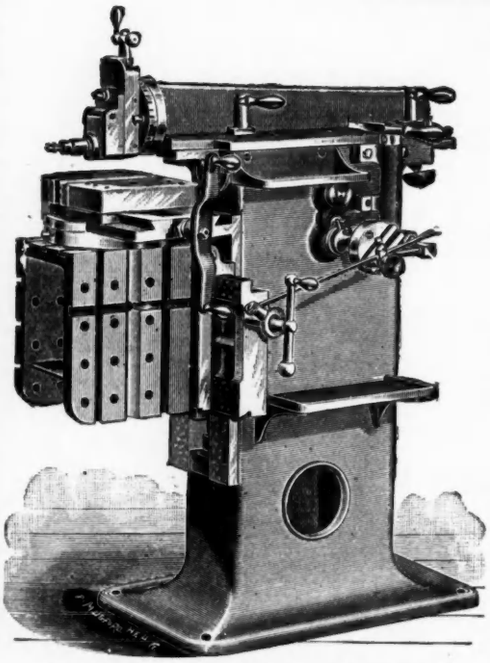

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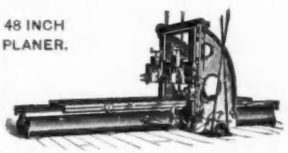
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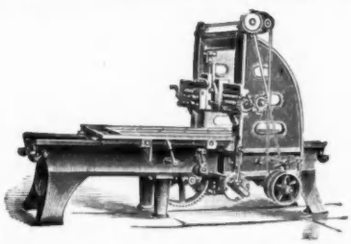
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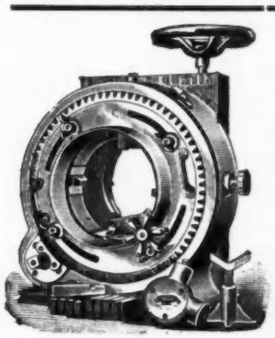
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The Morse Twist Drill and Machine Co., New Bedford, Mass., have issued their new 1896 catalog, which is larger than any that have preceded it, and includes illustrations and descriptions of a number of new tools not shown in previous catalogs. It is sent to those interested on application, and is 6 x 9¼ inches.

Link-Belt Machinery Co., Chicago, Ill., send us Catalog No. 20, which is a fine publication of its class, and contains a number of illustrations of machinery for conveying and handling materials of various kinds, principally coal. The catalog has a cover printed in colors, and is an attractive one. It is standard size, 6 x 9 inches.

White Sewing Machine Co., Cleveland, O., send us a catalog which they call a "Portfolio of Illustrations," and which catalog illustrates and describes the White bicycle. A portion of the illustrations are in color, and the catalog is an attractive and well gotten up publication, setting forth the merits of what seems to be in many respects an excellent machine. It is 7¾ x 7⅝ inches.

The Capital Machine Tool Co., Auburn, N. Y., have issued a new illustrated catalog and price list of machinists' vises, jack screws, bench screws, etc. One of the specialties recently brought out by this company is the "Tornado Bicycle Pump," made in three sizes, 1 to 1½ inches, with steel plungers, cupped leather packing and steel ball-valves with universal connections.

Mossberg Mfg. Co., Attleboro, Mass., send us a catalog in which are illustrations and descriptions of a very large assortment of machinery, most of which is especially adapted to the use of manufacturing jewelers and for similar lines of work. The catalog also contains illustrated description of the Mossberg roller bearings, which we have illustrated in our columns. It is standard size, 6 x 9 inches.

MANUFACTURES.

The Caskey Bros., of Philadelphia, Pa., have bought the Newport News (Va.) Iron and Brass Foundry, and will start it up.

The W. P. Davis Machine Co., Rochester, N. Y., have recently moved into their new plant. The new building is 130 feet long, with a frontage of 53 feet, and has five floors.

Mr. E. F. Spaulding recently resigned as vice-president and general manager of the American Engine Co., at Bound Brook, N. J., and Mr. Frank H. Ball was elected to the position.

The Etna Foundry & Machine Co., at Warren, O., has recently been formed, with Lloyd Booth as president, and H. M. Garlick vice-president, both of whom hail from Youngstown, O.

The Belknap Addressing Machine Company, of New York City, has recently been organized; capital, $100,000. Directors: Edward S. Wallace, Jardine Lyng and Charles H. Harper, of Brooklyn.

The Ellwood-Ivins Tube Co., whose mill is located at Oak Lane Station, Philadelphia, and office at No. 487 Broadway, New York, have discontinued their office at No. 906 Filbert street, Philadelphia.

The 2,000 employés in J. B. Sargent & Co.'s factory at New Haven, Conn., are to be put on an eight-hour schedule. Mr. Sargeant says there is overproduction because of the unsettled condition of the currency question.

The Cole Machine Company, of New York City,

has been formed; capital, $100,000. Directors: Henry W. N. Cole and W. L. Cole, of Brooklyn; D. M. Lowrey, of Philadelphia; A. W. Bronson and A. H. Bronson, of New York City.

Byron E. Parks, Mechanical Engineer, 74 Monroe street, Grand Rapids, Mich., has issued a card entitled "Tables of Standards of Steam Economy," on which are given in tabular form the standard figures relating to water and coal consumption in various types of engines.

There is a reported combination of gun making concerns, including the Driggs-Schroeder, the American Projectile Co., of Lynn, Mass., and the Hotchkiss Co. Gen. Ardway will be at the head of the new concern, and there is talk of building shops at Bridgeport, Conn.

The Windsor Brake Company, of Troy, N.Y., was recently organized to manufacture emergency and safety brakes for street railway cars; capital, $10,000. Directors: Daniel Gaffney and Morris Levy, of Troy; John T. Gorman, of Cohoes, and John Gibbons, of West Troy.

Gillie-Godard Company, of Tonawanda, N. Y., has been formed for the purpose of manufacturing merry-go-rounds; capital, $40,000. Directors: W. N. Gillie, of North Tonawanda; Philip Perew and William Godard, of Tonawanda; G. W. Quinland and W. J. Kearney, of Lockport.

The Capital Machine Co., Auburn, N. Y., report that their plant for making the Tornado Bicycle Pump is kept very busy supplying the demand for this pump, which is of that form in which the foot is inserted in a stirrup and the pump held to the floor, while the hands are left free for pumping efficiently. The pump has a steel plunger, cupped leather packing, and steel ball valves with universal connections.

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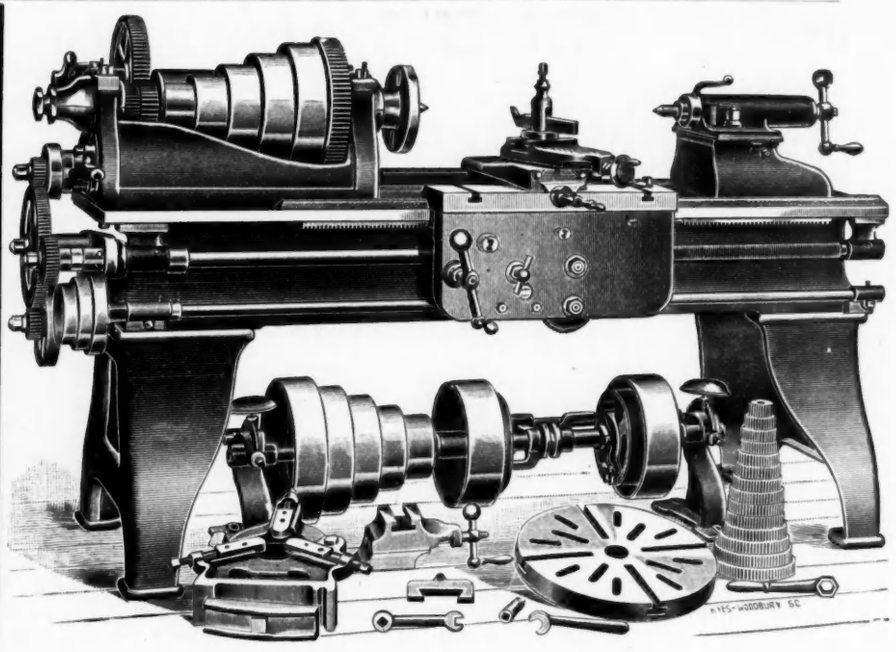

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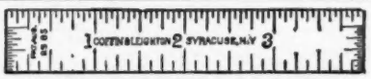

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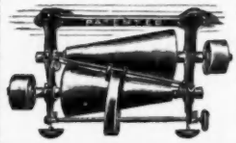

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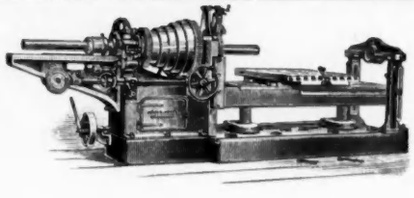

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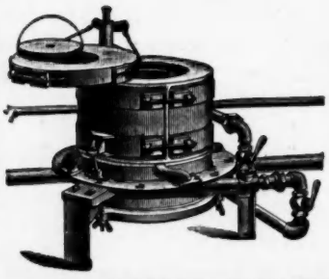

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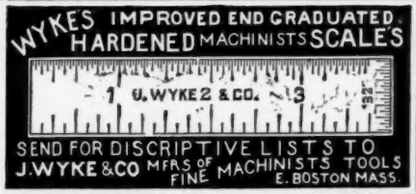
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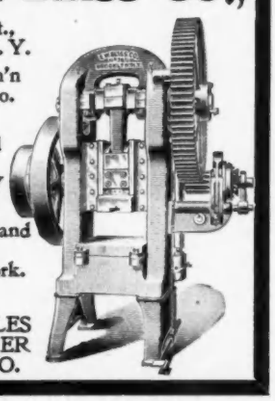
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